Does the Development of Mobility in Traffic Follow a Pattern?

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It might seem obvious that movements taking place in traffic systems display regularities or patterns. On the assumption that traffic flows do in fact exhibit regularities, it follows that if we were able to detect and decode such patterns we could then go on to modify them by changing the factors that produce them.

EXISTING TRENDS: THE PREVAILING VIEW

The increasing rate of motorization has caused a decrease in the patronage of public transport systems, as shown by Voigt[1] (Figure 1). This tendency may be observed in the existing data from all countries regardless of social,

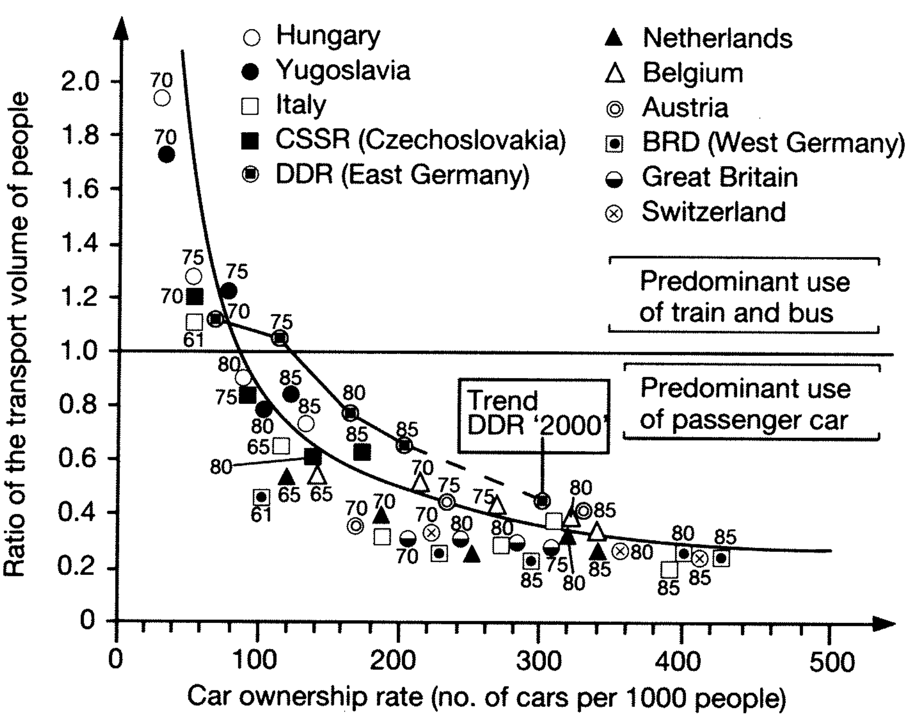
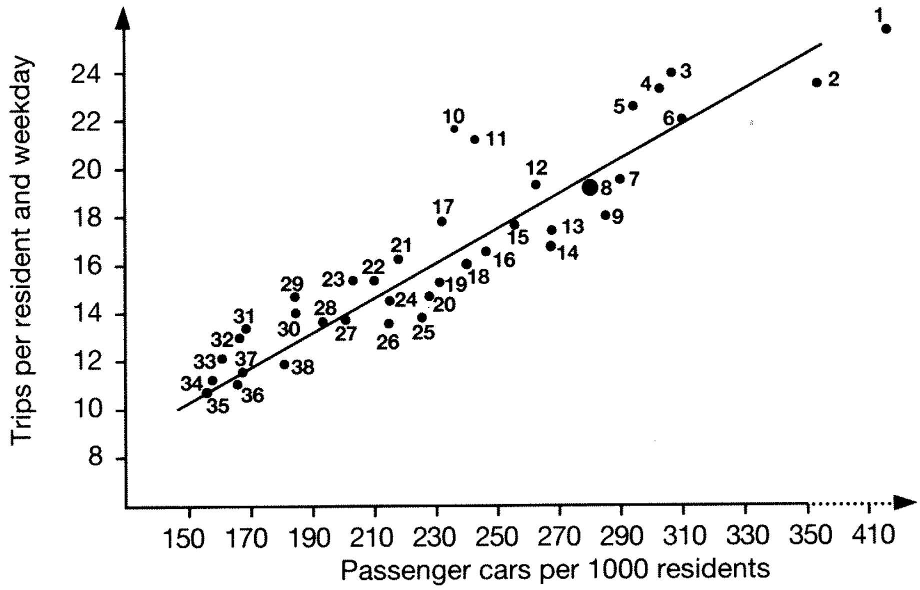


Figure 1 Ratio of public to private transport volume against car ownership rate. *Source*: Note 1, p. 109.



1 Reno 1955
2 Phoenix 1957
3 Charlotte 1958
4 Nashville 1959
5 Houston 1953
6 Kansas City 1957
7 St Louis 1957
8 KONTIV 1975
9 Detroit 1953
10 Ingolstadt 1969
11 Salzburg 1969
12 Chicago 1956
13 Washington 1955
14 Pittsburgh 1958
15 Aachen 1972
16 Munich 1970
17 Bonn 1970
18 Heidelberg 1969
19 Mannheim 1969
20 Nettetal 1970
21 Hamburg Region 1971
22 Erlangen 1967
23 Munich 1965
24 Grevenbroich 1970
25 Ludwigshafen 1969
26 Nuremberg 1967
27 Krefeld 1968
28 Fürth 1967
29 Gütersloh 1964
30 Ham 1965
31 Wuppertal 1964
32 Brühl 1964
33 Hanover 1962
34 Kreis Krempen-Krefeld 1964
35 Lünen 1966
36 Opladen 1966
37 Untere Werre 1967
38 Kreis Minden 1967

Figure 2 Relationship between average weekday trips and car ownership rate in thirty-eight cities.

Source: Note 2, p. 79.

economic and political conditions. No country has been able to reverse this trend, even if their transport policy has sought to do so.

It seems that mobility patterns follow a kind of natural law, being tied to the increase in motorization. Current traffic policy and traffic planning are based on the assumption that 'increasing motorization increases mobility'[2] (Figure 2). This is a basic hypothesis of traffic policy planning, valid until proven otherwise.

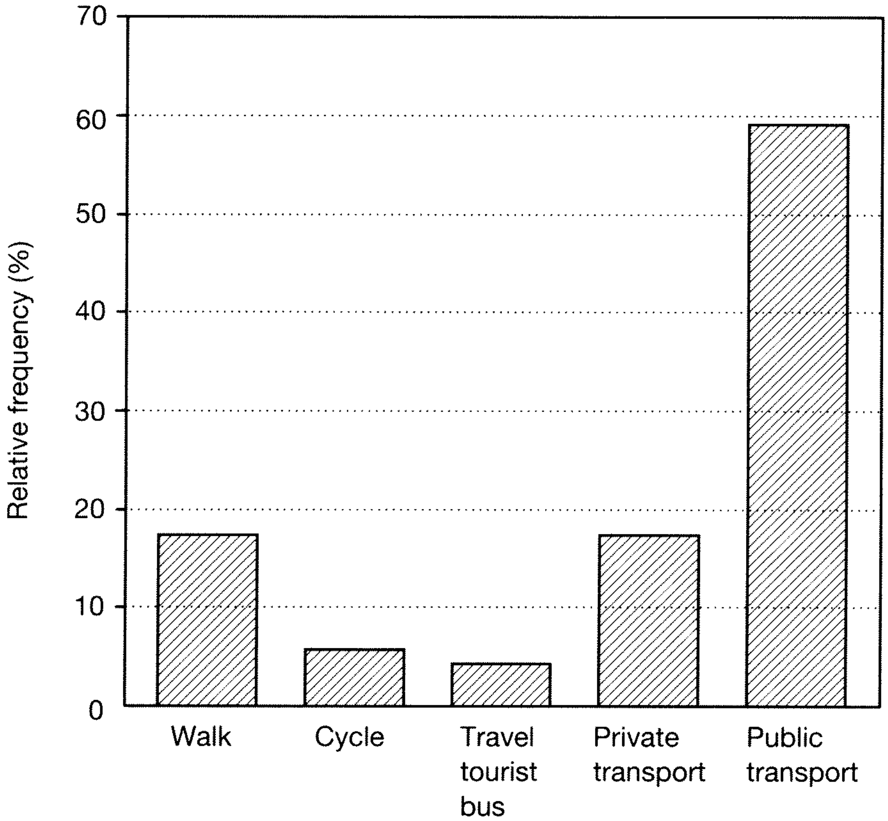


Figure 3 Means of transport to reach the first district of Vienna.
Source: Note 3.

Examination of the hypothesis

Modal split of the type of transport used by shoppers in Vienna's city centre
Figure 3 shows the result of a survey made in the city centre of Vienna.[3] Vienna has about 380 cars per 1000 inhabitants, but we can see that only 15 per cent of customers use the car for shopping in the city. The majority use public transport or walk. Vienna has an excellent public transport system in the city centre in the form of its Metro and a very pleasant pedestrian zone. We can see, therefore, that the hypothesis is not valid for customers in the city centre of Vienna.

Modal split of commuters dependent on parking places
Only 10 per cent of car-owning commuters who have a reserved parking place at their destination in the city use public transport (Figure 4). However, if they do not have a reserved parking space, about 30 per cent use public transport regularly.[4] (The parking policy in Vienna is not very strict, so it is not too difficult to find a parking place.) This is the second observation contradicting the hypothesis.

Effect of improved supply of public transport on modal choice
Traffic flow on radial roads to Vienna has increased at the same rate, or faster, than on the average Austrian road. In the 1970s, a *Schnellbahn* system (trains with a convenient half- or quarter-hour interval) was introduced on

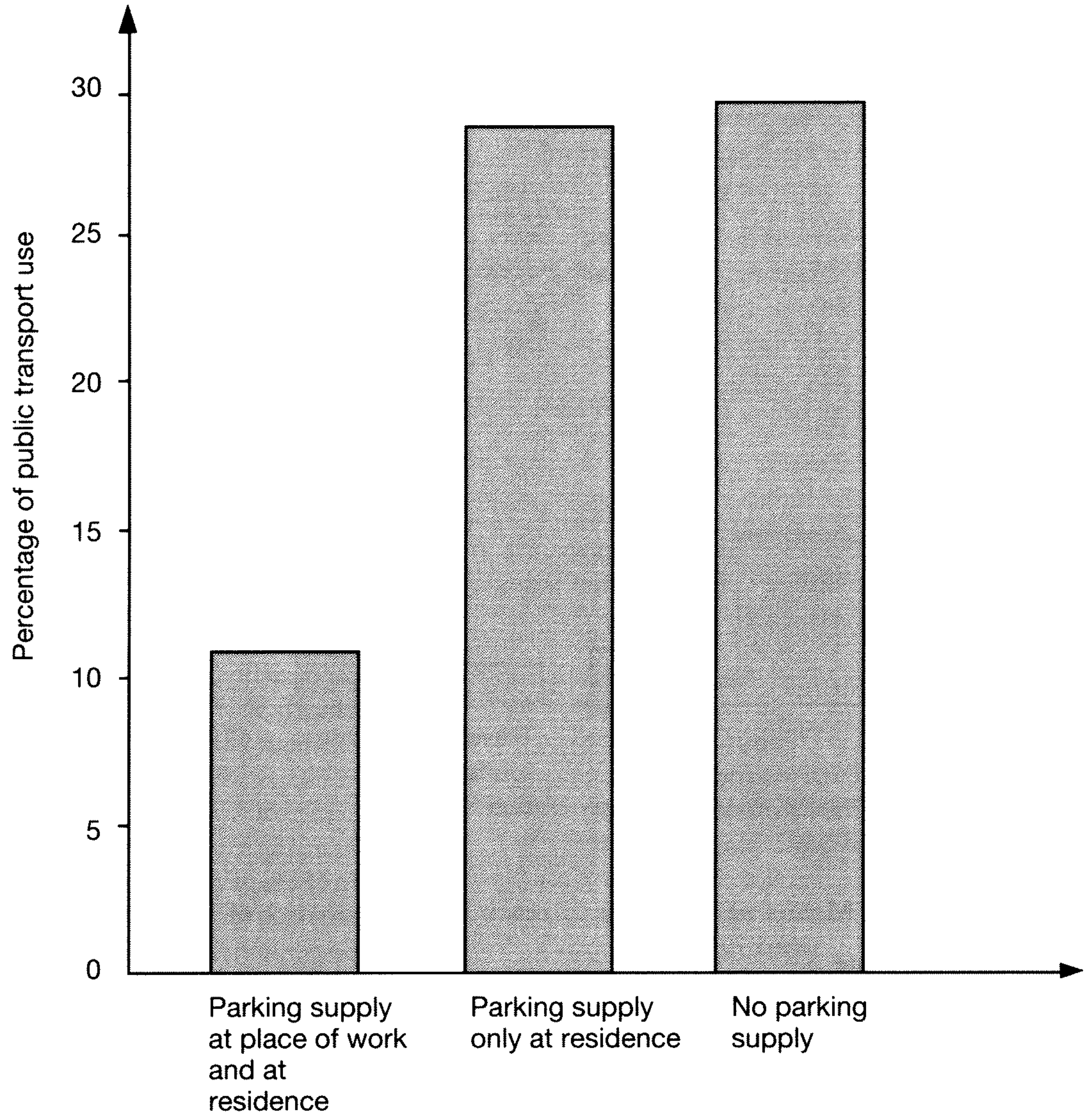


Figure 4 Participation of the season-ticket user.

Source: Note 4.

lines parallel to some of these radial roads, so that commuters would have an alternative to driving. The effect on road traffic was clearly visible.[5] Traffic flow at the end of the 1980s was no greater than at the beginning of the 1970s, although the total Austrian traffic growth rate continued to increase, as seen in Figure 5. This is the third observation contradicting the given hypothesis.

We can conclude from these three observations that the infrastructure and the quality of the traffic system both strongly affect the modal split, the possibility in this case of going either by rail or by road, and thereby also affect mobility patterns.

THE QUESTION OF MOBILITY

Car mobility is only one aspect of the physical mobility of people. Figure 6 shows a cross-section of the mobility of people between the ages of 6 and

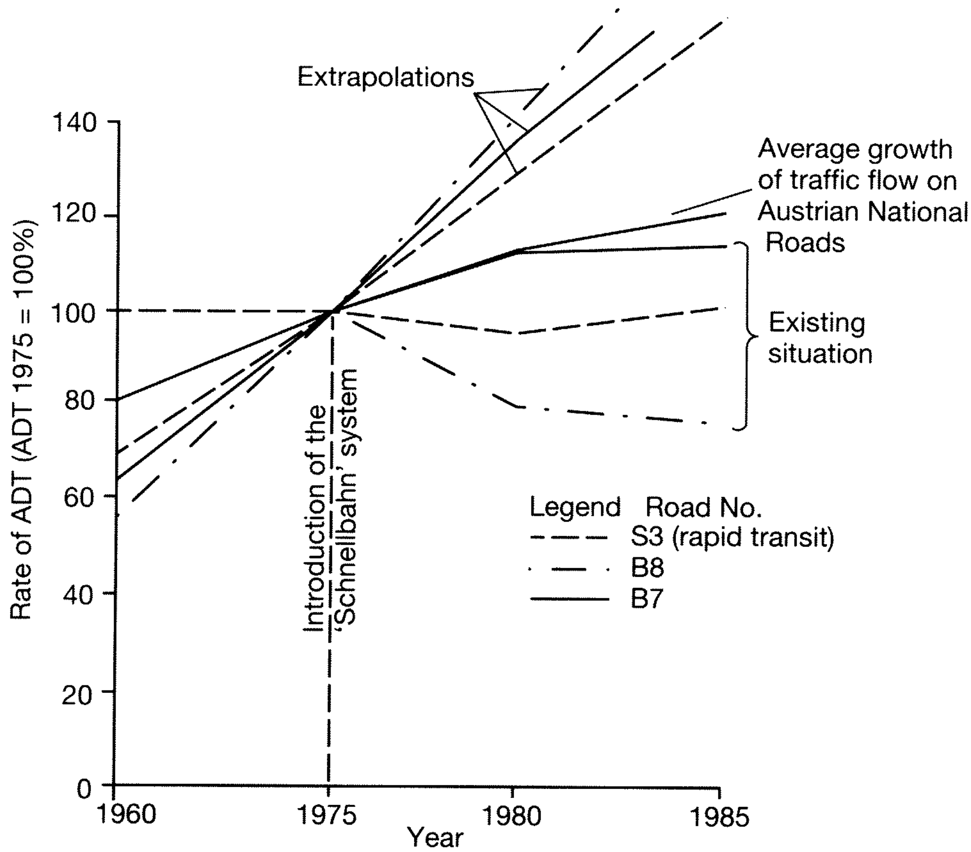


Figure 5 Development of traffic growth with respect to the rapid transit (Schnellbahn).

Source: Note 5.

90 living in a typical medium-sized Austrian city.[6] The absolute number of trips per person depends on age.

Car traffic constitutes only a part of total mobility, the bulk of which is pedestrian mobility, bicycles and public transport. It is important to note that mobility denotes not only physical but mental, social and housing mobility as well. These three factors play a large role in physical mobility because all of them can either inhibit or enhance physical mobility. Therefore it is useful to define mobility in terms of one person and his or her number of trips per day instead of in terms of transport modes. Studies worldwide show that this so-called mobility is not dependent on the development of technical traffic systems alone. Social demographic changes are responsible for most of the increasing mobility rate of recent decades. One of the reasons is the decreasing number of people per household. For instance, people living alone will make more external trips than people living as part of a couple, simply because the single person has to find social contact outside the domestic environment.

We have to accept that the number of trips per person per day does not change much if the transport modes are changed. Several studies show that this mobility rate seems to be constant. The distance travelled, not the number of trips, changes. Average travel time has remained constant, but increasing traffic mobility has caused the trip distance to increase.

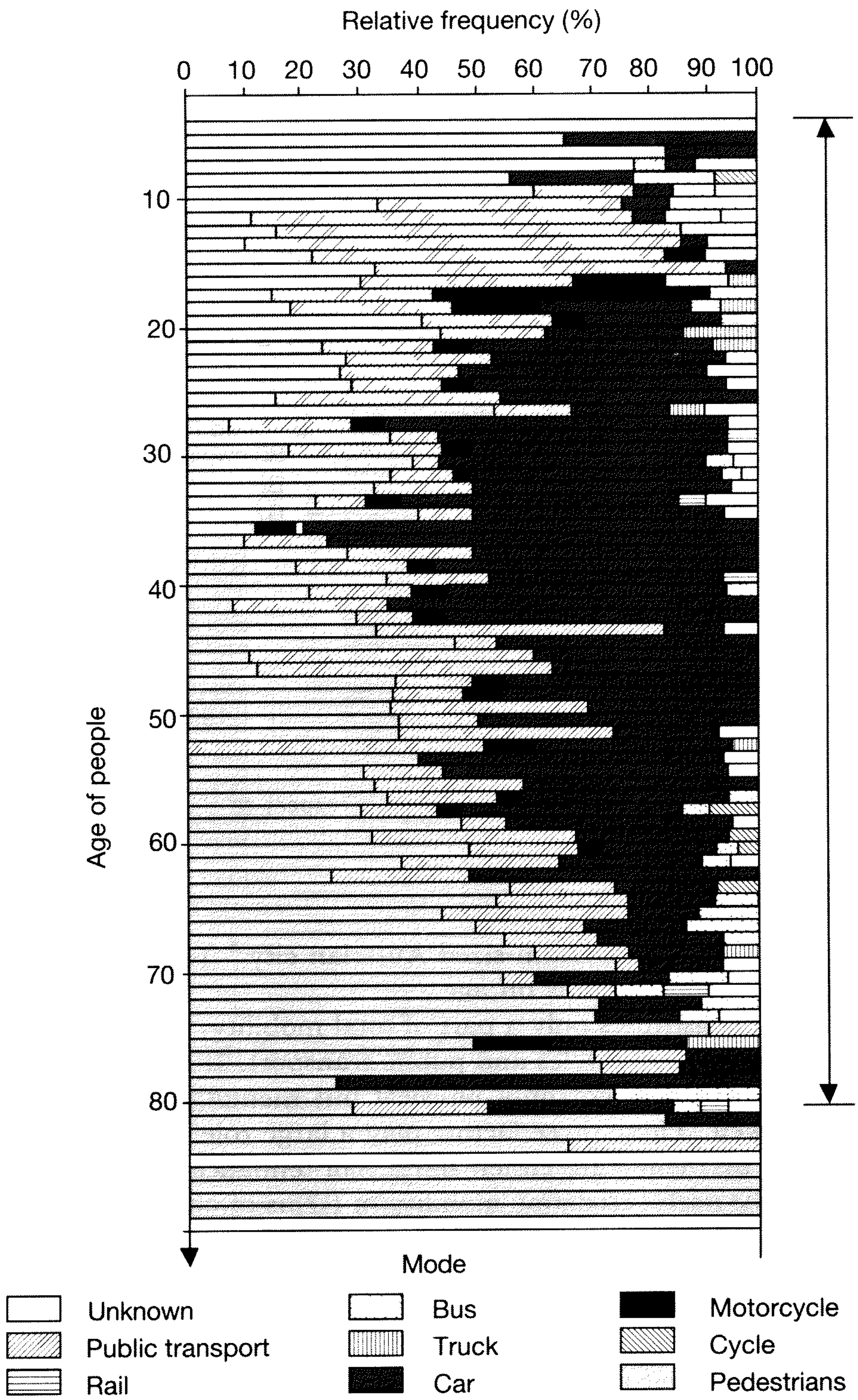


Figure 6 Distribution of mobility among different age groups and modes of transport.

Source: Note 6.

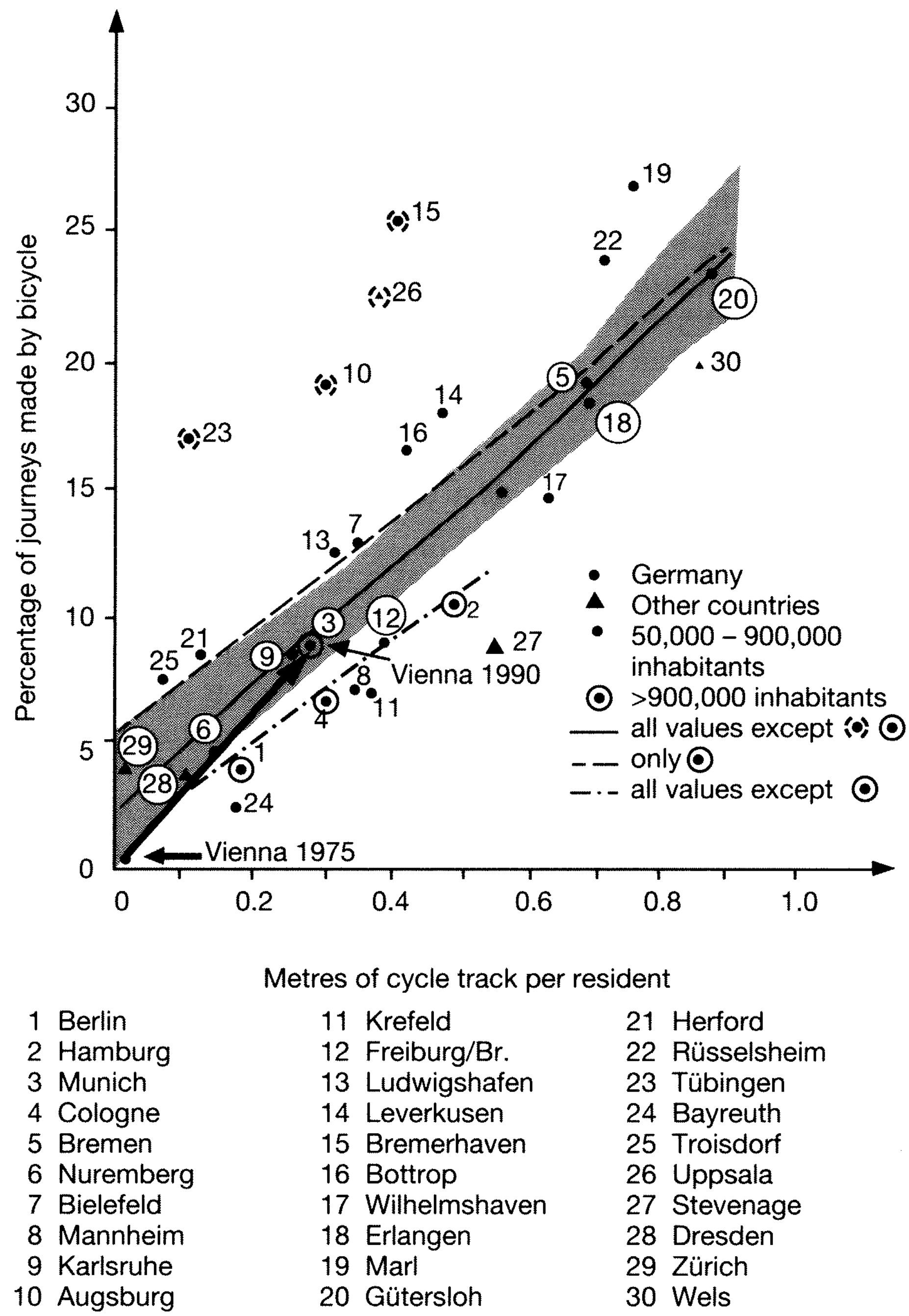


Figure 7 Relationship between choice of transport mode (cycle) and metres of cycle track per resident.

Source: note 7, p. 115.

Therefore increasing traffic-system speeds will not result in time savings. We cannot understand or change traffic systems by calculating time savings, since, as far as individual mobility is concerned, there is no time saving in the transport system.

What kind of regularities influence the modal split?

In 1975 a survey of cycle-tracks and the number of cyclists was carried out in German cities.[7] The results are shown in Figure 7. An increase in the number of cycle-tracks leads to an increase in the number of cyclists. This figure shows a relationship between human behaviour and infrastructure, in this case cycle-tracks. From this diagram we can see that Figure 2 shows an apparently incomplete correlation, one which presupposes the existence of a road network. For people to make car trips, roads must exist. If no road network exists, no corresponding pattern of car mobility will appear, even though people have cars.

If we look at the limited public space in cities and compare it to the basic space demands of different kinds of travel modes, it becomes obvious that we must set certain priorities. How can we move human behaviour in the direction of these priorities?

HUMAN BEHAVIOUR AS A RESULT OF EVOLUTION

Road and city planning are designed in terms of time and distance scales. If planning measures do not produce the human behaviour expected by planners and traffic politicians, then these two groups blame irrational human behaviour. It is unlikely, however, that the majority of people behave irrationally. Each person behaves in a rational and logical way as he or she sees the situation. Possibly this behaviour might be mistaken, or have negative effects in relation to the needs of the whole system, but not to the existing situation as the person sees it. Therefore we have to accept that people are not irrational but that the assumptions of politicians and planners are unwarranted.

Since we know that the traffic system does not follow any simple calculation of time-saving, the basis of traffic planning and traffic economy, we now have to question whether the traveller's perception of time corresponds to actual time measured by the watch.

In 1972, Walther conducted an interesting study in Bielefeld.[8] He asked public-transport users to estimate their walking time compared to their whole travel time. Then he compared their estimates with the real walking time. If the estimated time for walking was the same as the entire travel time then people would judge time accurately. One minute travelling in a bus would equal one minute's walking; if we divided the estimated time by the measured time, we would always get 1. However, the actual observations were quite different,[9] as shown in Figure 8. With increasing walking distance, an overestimation of walking time occurred when compared to the whole travel time. This result was called the 'time value factor'. The reciprocal of the time value factor may be defined as 'attractivity' (Figure 9). The attractivity of a walking distance declines sharply with increasing distance. A walkway 300 metres long has only about 20 per cent of the attractivity of one 50 metres long. We repeated these studies in Vienna[10] and the results supported those of Walther.

Bees follow the same pattern

Karl von Frisch observed that the frequency of bees' dances used to give distance information decreases with increasing distance to the feeding place.[11] We see that Frisch's observations resulted in an exponential curve similar to Walther's (Figure 10i).

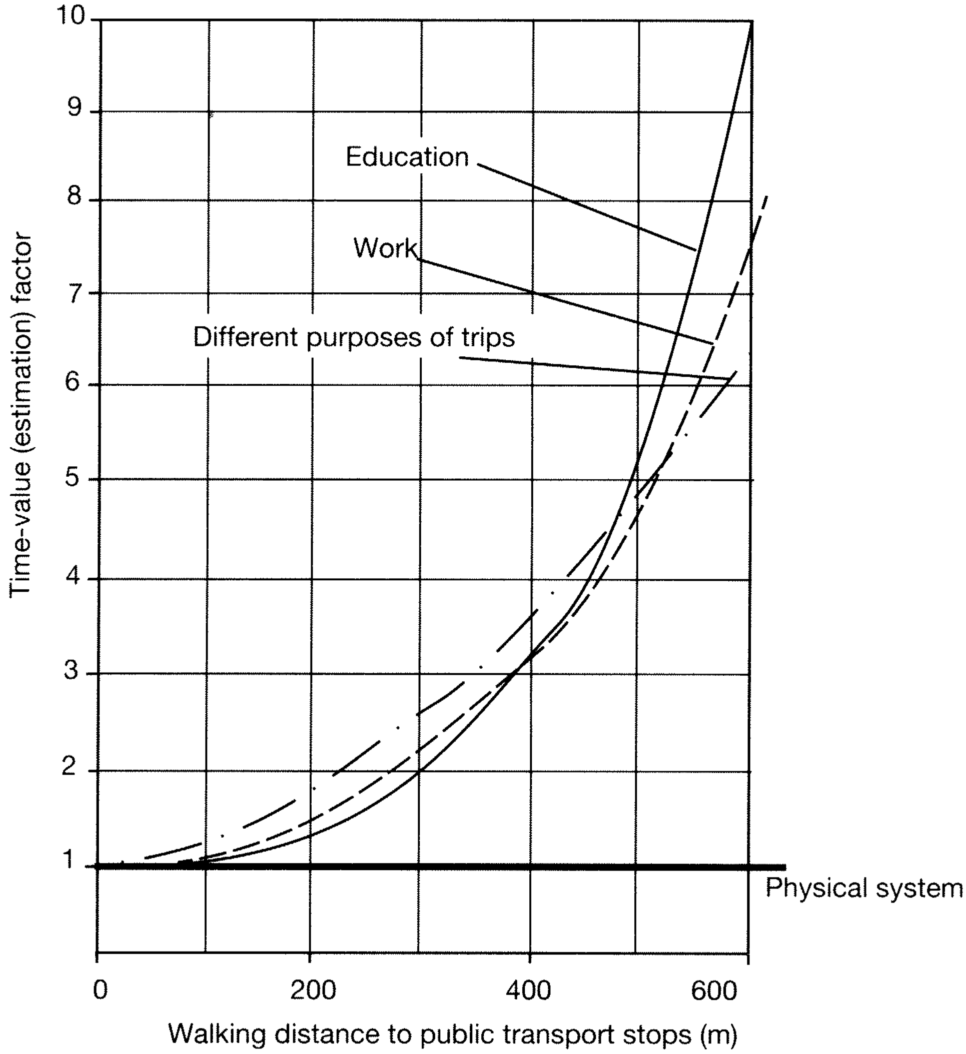


Figure 8 Time estimation of walkways compared to public transport travel times. *Source*: Note 8, Figure 42.

What is the reason for this similarity?
I think I can explain the similarity by means of the following analysis. In 1956 Karl von Frisch conducted an interesting experiment with bees that can also be taken as a key experiment for traffic planning.[12] Bees have the possibility of a modal split since they can both walk and fly.

The experiment modified the bees' environment by means of a channel leading from the beehive to the feeding place. The bees were forced to walk since they could not fly. Frisch and his colleagues recorded the information the bees gave after returning home when the channel was lengthened. It was interesting to find that after the channel was extended to lengths between 3 and 4 metres, the bees informed their fellow workers at home about a feeding place some 80 metres (flight distance) away. This means that the bees were 'lying', or do not measure distance as we do. Frisch discovered that for both distances, 4 metres walking or 80 metres flying, the energy consumption was the same. This was the cue to compare the energy consumption of man when walking, driving or using public transport.

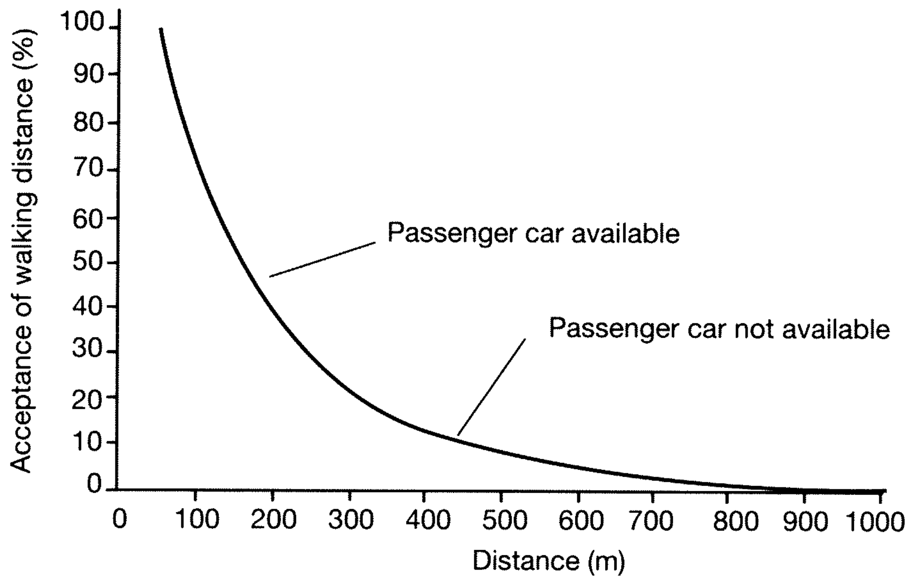


Figure 9 Acceptance of walkways as a function of distance.
Source: Note 8, Figure 23.

HOW DO WE CALCULATE ENERGY CONSUMPTION?

Frisch found a correct mathematical description or function (Figure 10ii), but I believe he drew the wrong conclusion.

At the beginning of the nineteenth century, Weber[13] and Fechner[14] discovered a fundamental law governing the reactions of organisms to external irritations. This law is called the Weber–Fechner sensation law; sensation (s) is equal to the natural logarithm of intensity of irritation (I).

$$s = \ln I$$

In the light of all this—what is traffic planning? Traffic planning consists of nothing more than the changing of external irritations and, therefore, sensations. If we were to use human body energy demand to describe traffic behaviour, then we should be able to find a way to explain and modify human traffic behaviour.

The sensation of a daily walk to work, shops or other interesting things is perceived as resistance. Resistance is recognized as negative. If we introduce a negative sensation into the Weber–Fechner law, we obtain the negative exponential (e) functions, which can be found in most functions describing the resistance laws of traffic systems. However, this explanation gives us a much deeper insight into the problem when compared to a formal description. We can now explain the traffic resistance law on the basis of the 'inner mechanism of man'.

The function is twofold. External irritation can also create positive sensations. Therefore it was interesting to check whether this twofold function

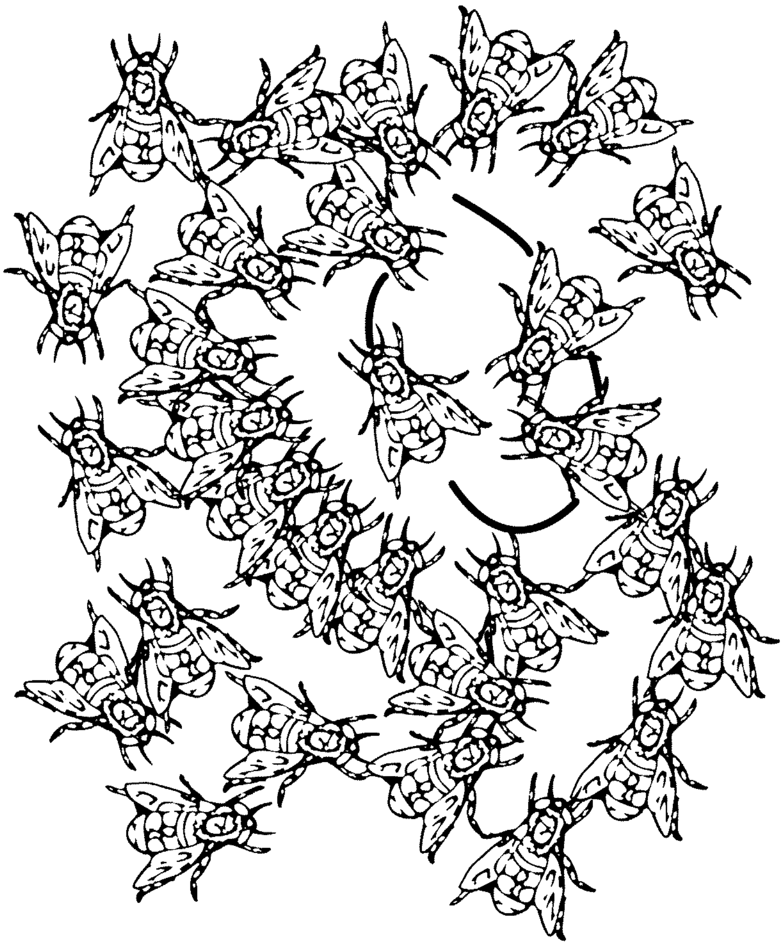


Figure 10(i) Dances of bees as source of distance information.

Source: Note 11, p. 61.

could be observed empirically. A student was given the task of observing the differences between public transport users going through a normal environment (car-oriented), and through a human-oriented environment (walking through parks or pedestrian zones) to reach their public transport stop.[15] The conditions were defined as

(a) an unattractive environment, car-oriented.

(b) an attractive environment, pedestrian zones and parks.

The results are shown in Figure 11. The curves are parallel, but the attractive environment 'extends' the attractivity of a walkway by up to 70 per cent or more.[16] In an unattractive environment, people tend much more strongly to avoid walking and to use a car if possible.

PEOPLE ARE 'CAPTURED' BY THE CAR AS A RESULT OF THEIR OWN ATTITUDE

Balances of energy and irritation are probably taking place in the brain at very deep evolutionary levels, presumably far below the level of consciousness.

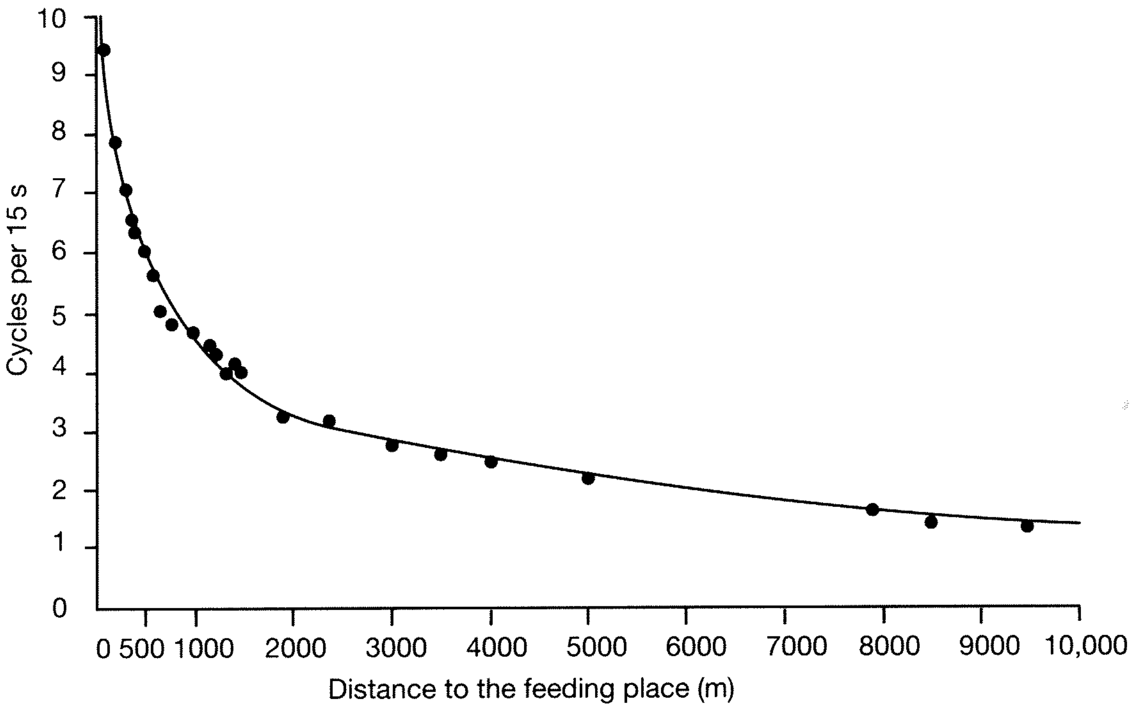


Figure 10(ii) Relationship between dancing speed and distance to feeding place.
Source: Note 11, p. 70.

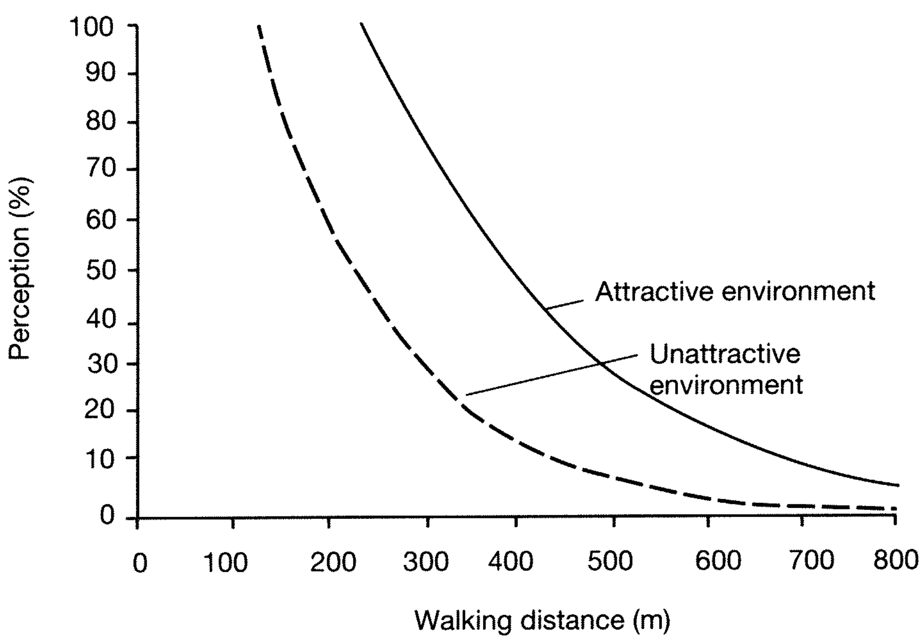


Figure 11 Influence of municipal structure on perception of travelling time: traffic to place of work, free alternative means of communication.

Source: Note 10, Figure 20.

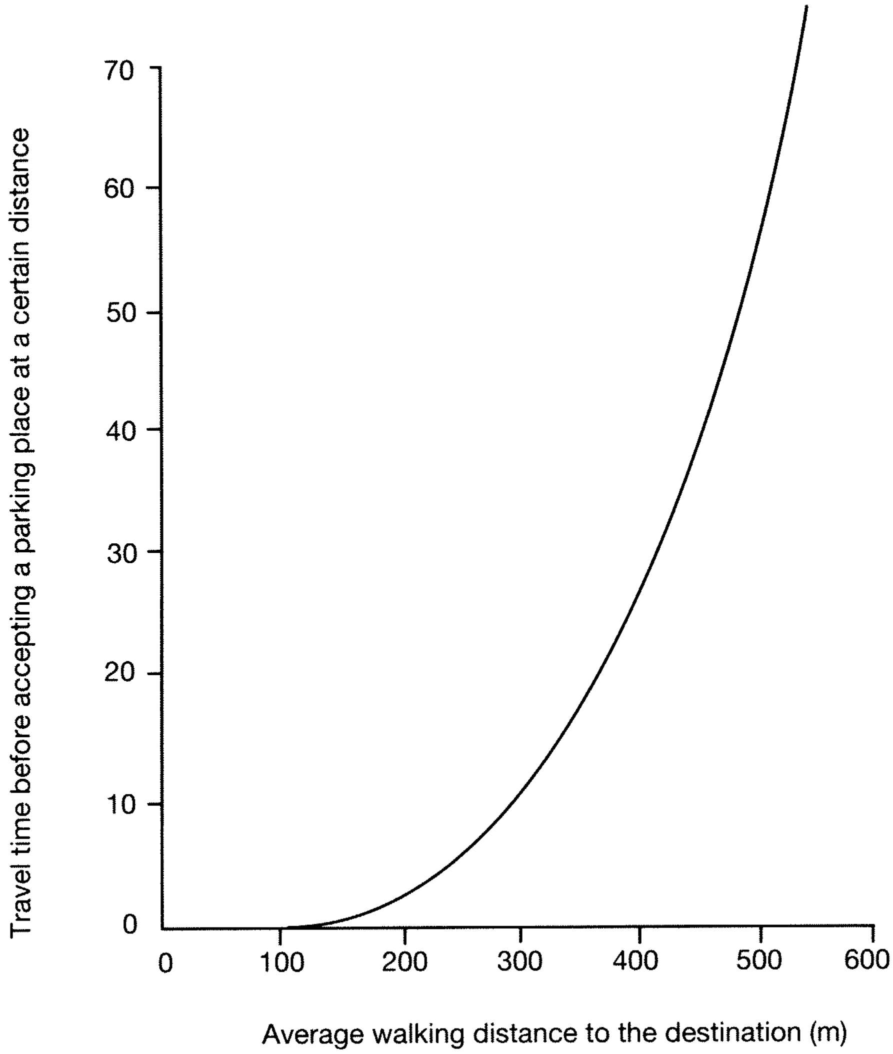


Figure 12 Average search time to find parking place closer to destination before accepting a certain walking distance.

Source: Note 17, p. 111.

It was also interesting to observe, therefore, for how long car users would search for parking places before they accepted a particular walking distance. This task was given to another student as a subject for his thesis.[17] The results are shown in Figure 12. We see that a distance of 100 metres or less between the destination and the parking place is accepted immediately by the car drivers. If the distance is increased to 300 metres, the car drivers look for a parking place closer to the destination for an average of 12 minutes; and if the distance is 400 metres, the searching time for a closer parking place is 28 minutes. This function, as well as the attractivity function in Figure 11, can be very easily calculated in terms of the Weber–Fechner law and energy balances.

We are captured by the construction of our cars for many reasons. The body energy consumption for sitting is much lower than for the upright standing position. The 'power of the legs' is increased by about 600 to 700 times if we use a car compared to walking, but the brain has not grown at the same rate. The brain concludes that we need less body energy to drive than to walk.

As car drivers, we are leaving human society behind since we are leaving the realm of the two-legged. Car drivers are 'four-legged' as they move. It is as if the space of activity has become similar to sitting on a branch in a tree, having a 'steering branch' in one hand, a 'gear branch' in the other hand, the legs having a 'braking branch', 'accelerating branch' and a 'clutch-pedal branch', and the whole tree is moving—really a fascinating thing.

The car is allied with the subconscious levels of our brain. Our captivity is nearly complete.

Consequences for our question

In all countries of the world we observe the same basic mistakes in the organization of traffic systems. The control mechanisms are not working efficiently, or do not exist at all. Traffic policy and traffic planning are oriented towards the big elements like roads, computerized signalling, railways, etc., not towards the small elements, the cells of the traffic system. We can define the cell of the traffic system as the household or the individual.

We can now look at the individual and his position *vis-à-vis* different traffic modes. Today, the situation worldwide is the same. The car is parked in front of the house or in the garage. The walking distance to the parked car, therefore, has nearly 100 per cent attractivity. The public transport stops are far away, sometimes 700 metres or more, thus the remaining attractivity of public transport is only a few per cent. Under these circumstances public transport has no chance at all. With increasing motorization, the level of public transport use must therefore decrease, following a negative e-function which is the result of the prevailing traffic organization and the relationship of cars to human activities compared to public transport stops.

What Voigt[18] has observed is nothing more than the realization of the Weber–Fechner law in this man-made environment. Therefore, the key for changing the system is not the planning of 'big elements' but much more a proper organization of the 'small elements'. This means the proper organization of parked cars, and caring for real human behaviour, which is oriented towards maximizing positive irritation (convenience) and minimizing negative irritation (consumption of body energy).

SOLUTION OF THE PROBLEMS

If we accept man as a reality, and not as a creation of planners and politicians, then we have to respect his fundamental nature. This means that we have to take into account his real behaviour, not his desired behaviour. If traffic policy demands some changes in public transport (most political programmes are promising priority for public transport), then this takes on real meaning. The consequences of this political goal is that we have to introduce the same distance between all human activities (living,

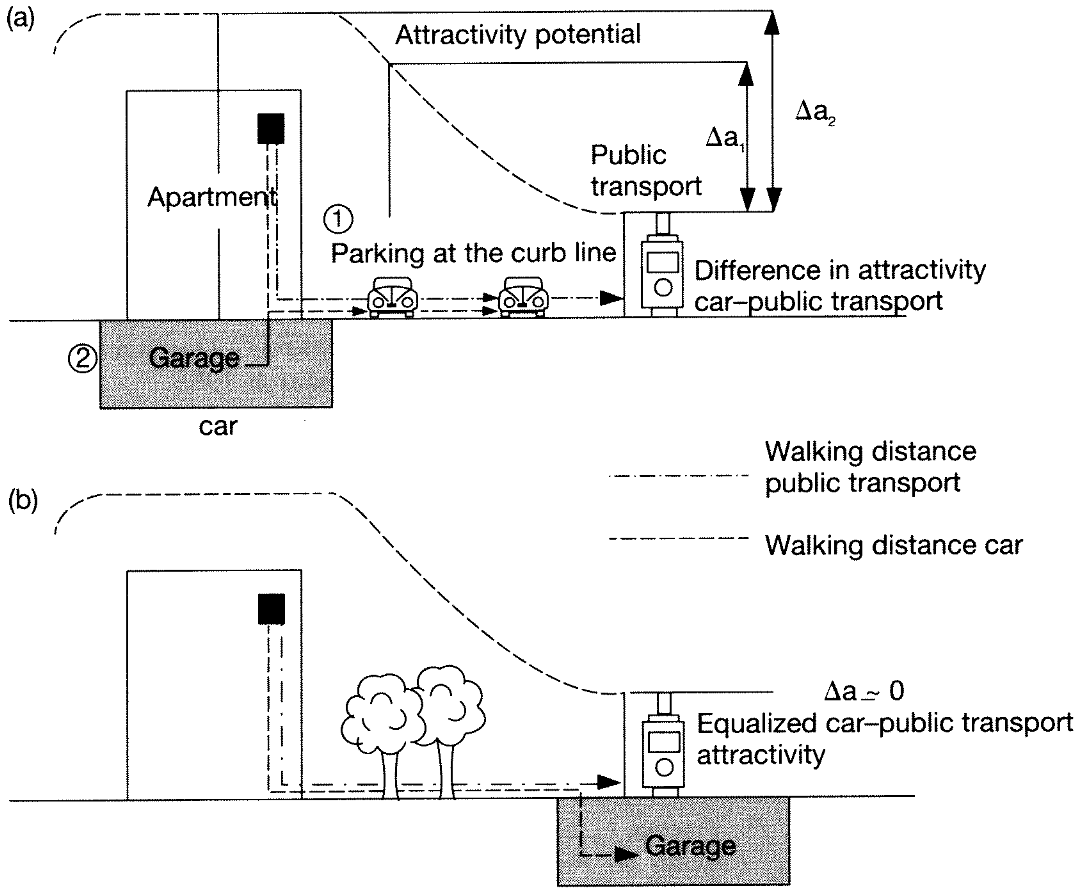


Figure 13 Solution of the problems: (a) existing situation and (b) proposed system.
Source: Note 19, pp. 150–4.

working, leisure, shopping, etc.) and the parked car that exists between these activities and the public transport stop[19] (Figure 13). This means that our residential areas must be cleared of cars. The cars must be stored in central garages at least as far away as the next public transport stop. The result would be car-free pedestrian environments with possibilities for cycling, social contacts, leisure, etc. Obviously such an arrangement would involve a massive change in our society and our economy, but the results would be extremely positive: more stable, well-developed residential areas, which also fulfil ecological needs. This kind of organization would take care of human needs as they are and not how we would like them to be. They present a tremendous challenge for all policies and strategies, and we cannot avoid either the needs or the implementation of these kinds of solutions if we accept the real nature of man on the one hand and wish to pursue a serious traffic policy on the other.

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