Are mopeds a type of motorcycle or a type of bicycle?

Mopeds off the cycle tracks: safer for cyclists, moped riders, and other road users

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ABSTRACT

A study was carried out to establish whether or not it is safer to allow mopeds to use the carriageway in built-up areas, in places where separate cycle tracks are available. An accident study was conducted in the form of a 'before and after' study under experimental and control conditions, in which accidents involving injury were analyzed. Three Dutch cities were involved in the study. It was shown that the measure 'mopeds on the carriageway' has exerted a favourable effect on injury-related moped accidents; their number has been halved in the experimental areas as compared to the pre-introduction period and control areas. The same result was found for the number of accident victims. In contrast, other types of accidents did not show this decrease. In particular, accidents between mopeds and cyclists, and between mopeds and cars fell substantially. The results of this study give reason for reconsidering the position of the moped - as a type of motorcycle rather than a type of bicycle. More detailed results and implications of this study are discussed.

Introduction

The risk to moped riders of getting injured or killed in a road accident is higher as compared to all other road user groups in the Netherlands; 3 times as high as the already high risk to bicyclists, and even 10 times as high as to car drivers. Around 100 moped riders get killed each year, and over 2,000 are involved in serious accidents (Noordzij, 1993). Traditionally, mopeds have been considered to be a type of bicycle. Most traffic regulations applying to bicyclists also hold for moped riders, e.g., regarding priority rules and their position on the road. In addition, moped riders do not need a driver's license, and their vehicles are not registered. On the other hand, they are obligated to wear a helmet and have to have third-party insurance; in these respects mopeds are treated the same way as motor vehicles. Mopeds are allowed to ride 30 kms/hour inside built-up areas, and 40 kms/hour outside built-up areas. In recent years, yet another type of 'bicycle' was introduced in the Netherlands: the so called low-speed moped ('snorfiets' in Dutch). This type of vehicle often looks more like a bicycle than mopeds do, and is allowed a maxium of 25 kms/hour; riders of such vehicles do not have to wear a helmet. One of the questions that arise is how all these different types of vehicles, with different speeds, can be mixed safely. In other words, which position on the road is safest for all types of vehicle concerned?

Since the introduction of the moped in the Netherlands, Dutch law has required that they - being regarded as a type of bicycle - use cycle tracks wherever they are available rather than the carriageway. Cycle tracks are cycle facilities that are separated from the carriageway by a narrow dividing verge or by kerbstones. Exceptions are permitted in some cases, but these must be indicated by road signs and are quite rare. For a number of years discussion has been taking place in the Netherlands whether or not it would be safer for bicyclists when moped riders were to make use of the carriageway instead of the cycle tracks. In practice, approximately 70% of the moped riders exceed the speed limits. Therefore, particularly inside built-up areas, the speed differences between mopeds and bicycles are much larger than the speed differences between mopeds and larger motorized vehicles. Cycle tracks usually have a width of about 2 m (inside built-up areas often even less than 2 m) and, e.g., moped riders overtaking the much slower riding cyclists can cause dangerous situations and accidents. From this point of view it could be argued that it is safer to regard mopeds as a (light-weight) type of motorcycle than as a type of bicycle.

The question of whether the traffic regulations governing the position of mopeds on the road should be changed was raised after the introduction of the 1990 Dutch Highway Code. However, no decision regarding such a change in legislation was taken at the time. Consequently, in order to obtain greater clarity, particularly about the possible effects of such a change on road safety, SWOV was asked to carry out a study into this matter. This study (see also Hagenzieker, 1993) might also be of interest to other countries; for instance, where one plans to design (more) bicycle facilities or is confronted with new types or larger numbers of light-weight types of motorcycle, and one has to decide which type of vehicle should make use of these facilities.

Accident studies conducted in the past had already indicated that it might be safer if moped riders would use the carriageway instead of the cycle track. However, firm conclusions could not be drawn from these previous studies because of methodological reasons. In the Netherlands, there are already a few situations in which mopeds use the carriageway rather than the cycle tracks available. Research on these situations has shown that they are relatively safe (Welleman & Dijkstra, 1988; Dijkstra, 1989; Dijkstra, 1991; see also CROW, 1989; Dijkstra & de Wit, 1990). However, one problem with this research is that it has only studied stretches of road on which the measure has already been in force for some time. It is therefore no longer possible to study the situation before and after the introduction of the measure (road safety may have been better before).

In order to investigate the effect on safety of "removing" the moped from the cycle tracks, a field experiment was set up in (parts of) three Dutch cities. The present accident study had a before-after design with experimental and control areas. The pre-introduction period involved three years, 1989-1991; the post-introduction period involved the year 1992. An experimental situation incorporating the new measure was set up in (parts of) three cities. From 1 November 1991, mopeds were directed from cycle tracks onto the carriageway of a number of roads with a maximum speed limit of 50 kms/hour.

Low-speed mopeds were instructed to remain on the cycle tracks for the duration of the study. The cities themselves selected the experimental routes within their built-up areas. In all three cities, the public was warned of the introduction of the measure through pamphlets, posters and local newspapers. Obviously, road-users were also notified by signs on the side of the road and at intersections.

Method

Behaviourial observations and accident data were used to assess the new measure.

Behaviourial observations. Before the measure was introduced, and for six months afterwards, moped-riders were observed at a number of locations on the experimental routes, and the manoeuvres they made and their encounters with other road-users were registered. The study also noted their degree of compliance with the new measure and their speed (see Hagenzieker & Lubbers, 1992).

Accident study. The study covered both experimental and control routes. The *experimental routes* were defined as the roads with cycle tracks in all three cities where the measure was introduced (a total of over 38 kms of road length). The effect of the measure is intertwined with the development of road safety over time. In order to keep these two effects apart, *control routes* were also used in the study. In two cities these control routes were defined as all other roads in the built-up area with cycle tracks. In the third city, the measure was applied to *all* roads with cycle tracks. Consequently, a separate reference city was selected as a control area for this city, which is similar to it in a number of respects except that the new measure had not been introduced there. All the roads with cycle tracks in this reference city were therefore used as a control route for Tiel. The control routes for all three cities covered a total of almost 106 kms of road length.

Types of accident

The measure was expected to have an effect on accidents between mopeds and bicycles. These accidents were therefore looked at separately. Since the measure could also affect other types of accident, these were included in the analysis as well. The behaviourial observations had shown that on average, mopeds and bicycles experienced less 'mutual conflict' while mopeds and cars tended to experience more 'mutual conflict' after the introduction of the measure. Therefore, the types of accident were also classified in terms of the other party involved. A further subdivision was made according to 'road stretch' or 'intersection', depending on where the accident occurred. Finally, a subdivision in terms of city was required, since there were indications that the degree of compliance with the new measure was not the same in all three cities (Hagenzieker & Lubbers, 1992). The seriousness of the accidents (expressed in numbers of fatalities, hospitalisations and other injuries) was also taken into account.

Attribution of accidents to experimental and control routes

Only those accidents in which at least one of the (primary) parties was using an experimental or control route were included in the accident analysis. This was easy in the case of accidents on road stretches, but less easy for accidents at intersections, since not all the legs of an intersection located in a selected area were part of the experimental or control route (that is, roads with cycle tracks). Only those intersection accidents were selected in which at least one of the parties was using a leg of the intersection which was part of a designated experimental or control route.

The term *moped accidents* is taken in the following analysis to mean accidents involving injury in which the moped-rider - or in the case of accidents between two mopeds, in which at least one party - was using part of the designated route (that is, a road with a cycle track). *Bicycle accidents* were taken to mean accidents involving injury in which the cyclist - or in the case of accidents between two bicycles, in which at least one party - was using part of the designated route. The term *other accidents* was taken to mean all other accidents involving injury in which one of the parties was using part of the designated route.

Traffic volume and road characteristics

It is possible that important differences in the volume of car, bicycle and/or moped traffic on the experimental routes influence the effect of the measure. The same applies to road characteristics such as one- or two-way cycle tracks or single or dual carriageways. These characteristics were taken into account in the accident study.

Pre-introduction and post-introduction period

The pre-introduction period covered the last three years prior to the introduction of the measure (November 1988 to October 1991 inclusive). The post-introduction period covered the year 1992.

Results

A total of 2,462 accidents involving injury were selected for the accident study; this covered the total number of accidents for the experimental and control routes and for the pre- and post-introduction period. 729 of these were moped accidents, of which 258 occurred on the experimental routes.

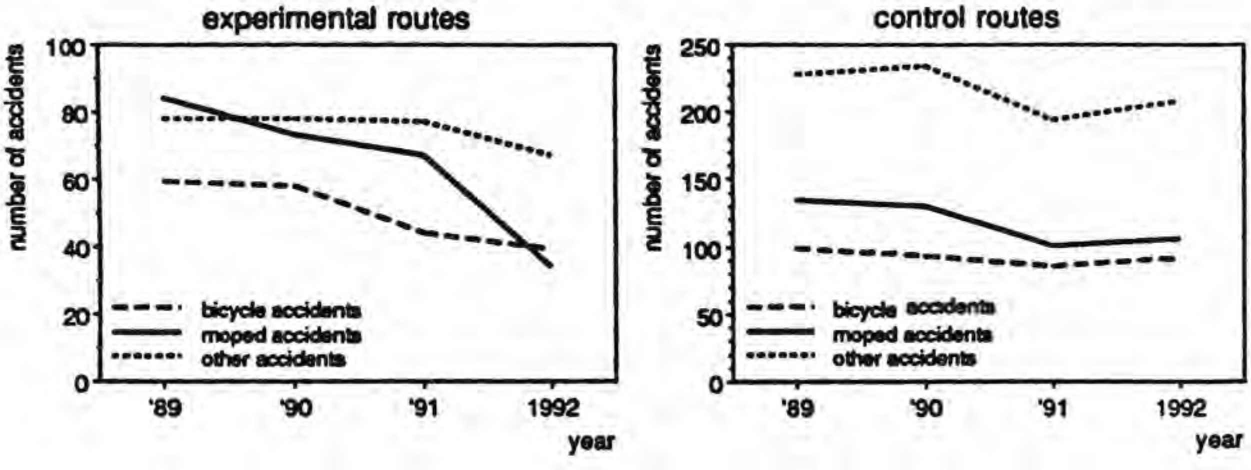

Figure 1. *Number of accidents on experimental and control routes per year*

Figure 1 gives an overview per year of the three aforementioned categories of accident studied on all the experimental routes together and on all the control routes together. It shows that on the experimental routes, only moped accidents show a clear drop in number, if the three years comprising the pre-introduction period are compared with the post-introduction period. For the other categories of accident, there is no clear (downward) trend over the years. If the figures are tested statistically, then none of the three categories of accident on the *control routes* shows a significant change over the years (χ^2=1.91; [df=6]; NS). If the period between November 1988 and October 1991 inclusive (abbreviated in the illustration to '89, '90 and '91) is examined more closely for the *experimental routes*, it is revealed that these pre-introduction years also show no significant variations from each other in respect of any of the three categories of accident (χ^2=1.96; [df=4]; NS). And if we examine the different categories of accident on the experimental routes separately, then it appears that only the category *moped accidents* shows a statistically significant decrease (χ^2= 10.00; [df=3]; p=0.018). Although on the experimental routes, bicycle accidents and other accidents show a decreasing trend over the years, this fall is not statistically significant. It is therefore plausible that the 'moped on the carriageway' measure has mainly had an effect on the number of moped accidents.

On the experimental routes the risk, expressed as the number of moped accidents per kilometre road length per year, was higher during the pre-introduction period as compared to the risk on the control routes (1.96 and 1.15, respectively); in the post-introduction period this is reversed, the risk on the experimental routes has decreased to an average of 0.91, whereas the risk on the control routes is 1.00. Hence, it appears that the cities involved in the study have - on average - selected those routes as experimental routes on which relatively many moped accidents occurred.

Accident victims

An examination of the numbers of victims reveals the same picture as for the numbers of accidents. For the category of moped accidents in particular, the total number of victims on the experimental route fell significantly from an average of 84 per year in the pre-introduction period to 37 in 1992 (χ^2=10.95; [df=1]; p<0.001). This decrease is visible in all categories in terms of the seriousness of the outcome of these accidents (i.e. fatalities, hospitalisations, other injuries). The decrease in the number of victims in the category of moped accidents can be seen in two of the three cities (not in Tiel).

A closer examination of moped accidents

A closer examination of moped accidents shows that their decrease in number is highly consistent with the decrease in accidents with bicycles (χ^2=8.27; [df=1]; p<0.01) and larger motorised vehicles (χ^2=4.65; [df=1]; p<0.05). Table 1 shows that at intersections, there were fewer accidents with larger motorised vehicles (χ^2=7.39; [df=1]; p<0.01); particularly motor vehicles turning off and crossing over. Table 2 shows that on road stretches in between intersections, there were mainly fewer accidents with bicycles (χ^2=7.25; [df=1]; p<0.01); usually overtaking accidents.

If a distinction is made as to the position of the moped at the time of the accident (i.e. whether or not it was on the cycle track), there is evidence of a substantial decrease in the number of accidents in which the moped was using the cycle track (χ^2=16.16; [df=1]; p< 0.001). Since mopeds were no longer allowed to use cycle tracks, such a decrease was expected, and this fact gives an indication of the degree of compliance with the measure, which was evidently very reasonable on average. However, around half of the moped accidents were still occurring on cycle tracks. A slight increasing trend in accidents between motor vehicles and mopeds on the carriageway was found, which is in line with the behavioural observations (Hagenzieker & Lubbers, 1992). However, this decrease was not statistically significant.

Intersections	Experimental routes		Control routes	
	pre	post	pre	post
moped vs motor vehicle	37	14	64	57
moped vs bicycle	6	1	8	4
moped vs other	7	7	9	9
Total	50	22	81	70

Table 1. *Average number of moped accidents at* ***intersections*** *involving injury during the pre- and post-introduction periods for the experimental and control routes.*

Road stretches	Experimental routes		Control routes	
	pre	post	pre	post
moped vs motor vehicle	7	6	16	10
moped vs bicycle	7	1	10	16
moped vs other	11	5	15	10
Total	26	12	41	36

Table 2. *Average number of moped accidents at* ***road stretches*** *involving injury during the pre- and post-introduction periods for the experimental and control routes.*

Moped accidents in relation to background characteristics

Almost three-quarters of the length of the entire experimental route consisted of *single-lane carriageway* roads; the rest consisted of *dual-lane carriageways*; two-thirds of the control routes consisted of single-lane carriageways. On the experimental routes, the main decrease in moped accidents was registered on single-lane carriageways; from 55 per year on average during the pre-introduction period to 22 during the post-introduction period (χ^2=6.54; [df=1]; p<0.05). There was also a decreasing trend in moped accidents on dual-lane carriageways, from 20 per year on average during the pre-introduction period to 13 during the post-introduction period, although this decrease is not statistically significant.

The majority (i.e. 70%) of the cycle tracks on the experimental routes in all the cities were *one-way cycle tracks on each side of the road.* Two-way cycle tracks (on one or both sides of the road) covered 19% of the total length of the experimental route. The rest were either one-way cycle tracks on one side of the road or low-speed service roads. The control routes were similarly subdivided. The decrease in accidents was relatively greatest on the one-way cycle tracks on both sides of the road. Such accidents fell from an average of 50 moped accidents a year in the pre-introduction period to 21 a year in the post-introduction period (χ^2=8.04; [df=1]; p<0.01). Taking the different types of two-way cycle tracks together, these also show a decreasing trend in moped accidents, from 19 per year on average in the pre-introduction period to 11 in the post-introduction period; however, this trend is not statistically significant (small numbers).

On all the experimental routes, the *relatively low classes of volume of larger motorised vehicles* were overrepresented as compared to the control routes. Also the *relatively higher classes of moped volume* and the *relatively higher classes of bicycle volume* were over-represented on the experimental routes. The strongest decrease in moped accidents could be seen on the relatively quiet roads along the experimental routes as regards the volume of larger motorised vehicles and mopeds, and on the relatively busy roads as regards the volume of bicycles. Yet in the other categories of vehicle volume, there was also a decrease - albeit less pronounced - in moped accidents.

Speed

The behaviourial observations showed that the speed driven by moped-riders increased after the measure was introduced. Six months after its introduction, the average speed of mopeds on carriage-ways was registered at between 44 and 45 kms/hour. Around two-thirds of mopeds drove at the same speed as the faster-moving traffic with which they were sharing the road. The average speed of this general traffic was between 49 and 50 kms/hour.

Compliance

In mid-1992, it appeared that an average of 85% of the moped-riders were complying with the new measure (see Hagenzieker & Lubbers, 1992). At the beginning of September 1993, compliance with the new measure was reasonable: an average of 80% of moped-riders respected it.

In the Netherlands, 'compulsory' and 'non-compulsory' cycle tracks exist; they are indicated by different road signs. During the experiment it was found that indicating the new measure by means of road signs in line with existing traffic regulations gave rise to a problem. Two of the cities opted for an advance warning sign in the form of a rectangular yellow board with black letters placed alongside the cycle track. The traffic on the carriageway was not warned that mopeds were being directed onto the road. The cycle track itself was marked with a blue rectangular 'non-compulsory cycle track' sign (road sign G13; see figure 2a). This sign means that the cycle track is only open to bicycles (but they do not have to use the track) and not to mopeds, including low-speed mopeds. Yet it had been agreed that low-speed mopeds should continue to use the cycle tracks. In practice, all low-speed mopeds did in fact continue to use these tracks. In the third city, this situation was clarified by placing an extra sign under the blue G13 road sign with the words 'low-speed mopeds excepted'. The advance warning sign was also clarified in such a way that it was obvious to both mopeds and other road-users where they should be. However, although this solution was clearer for road-users, it did not formally prevent bicycles and low-speed bicycles from using the carriageway. It is in any case questionable to what extent moped-riders can distinguish between road sign G13 ('non-compulsory cycle track') and the standard G11 road sign ('compulsory cycle track'; see figure 2b) which had been there before. A recent study on the familiarity of road-users with traffic regulations showed that over half of those questioned thought that road sign G13 ('non-compulsory cycle track') meant that mopeds were *not* allowed on the carriageway (Goldenbeld, 1993). Some of the problems of compliance with the new measure could be attributed to this.

Figure 2a. *Non-compulsory cycle track (road sign G13).*

Figure 2b. *Compulsory cycle track (road sign G11).*

Discussion and conclusions

When the three experimental areas are examined independently, the effects described above are found in two of the three experimental areas. In the smallest experimental area no effect at all could be seen (although no negative effect was observed either). The most probable explanation for this seems to be that there may have been some effect there as well, but it cannot yet be demonstrated. Only a very small number of moped accidents had occurred there: six in 1992 and an average of six a year during the pre-introduction period. Such small numbers make it almost impossible to show a decrease in statistical terms.

Although after a year, the overall effect of directing mopeds onto the carriageway has been a positive one, the evidence is still not conclusive enough to warrant introducing the measure on a large scale. A follow-up period of (at least) three years is felt to be necessary before it is possible to make more conclusive recommendations. Therefore, the accident study will be repeated in 1995, using the data which will by then be available. An assessment study with a longer post-introduction period would also provide an opportunity to examine whether any effect can be demonstrated in the one city without a positive effect to date, and to what extent the traffic volume and road characteristics on the experimental routes influence the measure's effect, and the size of that effect.

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Based on the accident data analyzed so far, it can be concluded that the measure designed to redirect mopeds onto the carriageway has had a positive effect on safety on roads in built-up areas with a maximum speed limit of 50 kms/hour. It has not only become safer for bicyclists, but also for moped riders, as well as for other road users on the experimental routes where mopeds did not use the cycle track anymore. The most striking finding of the evaluation study was the dramatic average decrease (by about half) of the so-called moped accidents (in which at least one moped was involved) on the experimental routes, compared with almost no change in the numbers of such accidents on the control routes. Moreover, the number of bicycle and other accidents on experimental routes show no difference on average to the situation on the control routes. In view of the way the study was carried out, with experimental and control routes and a pre- and post-introduction period, this decrease in moped accidents may well be attributable to the new measure. Mixing mopeds with motor vehicles - thereby treating them as a type of motorcycle rather than a type of bicycle - appears to be much safer than mixing mopeds with bicycles.