Why don't they go by trike?
Image of and attitudes towards tricycles for (older) adults.

J. Krause, C. Hagemeister, H. Bunte

[1] Department of Psychology
TU Dresden
01062 Dresden, Germany
e-mail: Julia.Krause1@gmx.net

[2] Department of Psychology
TU Dresden
01062 Dresden, Germany
e-mail: Carmen.Hagemeister@tu-dresden.de

[3] Department of Psychology
TU Dresden
01062 Dresden, Germany
e-mail: Heike.Bunte@tu-dresden.de

ABSTRACT

For older road users, crashes have more severe consequences than for younger road users due to their higher physical vulnerability. Physical difficulties make cycling more difficult for older persons: turning around before a left turn, stepping on and off the bike, and keeping balance. Handling these problems might be easier if cyclists with physical problems use a tricycle instead of a bicycle but – as evident on the roads – this option is chosen by a very small minority of older cyclists. The presented online study intends to find out what the image of tricycles in Germany is and what attitudes persons have about older persons using a tricycle. Questions about tricycles are presented, and one example of a recumbent and an upright tricycle are compared to an ordinary bicycle to establish the main assumed advantages and disadvantages of tricycles. So far, more than 800 adults have answered the questionnaire.

The participants see the greatest difference to an ordinary bike in the fact that a tricycle attracts attention. Other major differences are weight, the need for more space in traffic, and that one can not easily cycle on small paths and bike paths. It is assumed that a tricycle needs much less balance, but the expected safety benefit is low. In general, many major disadvantages are expected from tricycles, but only minor benefits. This shows that, at this point, persons who feel unsafe are unlikely to switch to a tricycle. General positive statements that tricycles can help older persons to remain mobile and independent are confirmed by the majority of participants but only a minority can imagine riding a tricycle themselves. Considering the fact that the participants of the study were open-minded towards the topic of the study, the current general acceptance of tricycles for personal use can be expected to be much lower. To become a “normal” part of traffic, extensive improvement of the image of tricycles is required.

Keywords: older cyclists, safety, tricycle, safety, marketing.

1 INTRODUCTION

As the majority of bicycle crashes are single bike crashes [1], tricycles – which demand less skill and less balance – might improve the traffic safety of cyclists with physical problems. Tricycles for adults are not a common vehicle. This means that a product which might help to improve traffic safety exists, but that there is little demand for this product. If one wants to make this

product more popular its marketing has to be improved. Therefore, more knowledge about the perception of tricycles is required.

Products are bought only if they meet certain criteria: (1) They must fit to the person's lifestyle. (2) If the product is expensive the potential buyer must have the opportunity to try it before deciding to buy it. (3) The product must be easy to understand and to use. (4) Only products which are seen are bought. (5) The most important criterion is that the buyer must expect the product to be useful for him or her. [2] Innovative products are only bought if they have all the positive attributes of the existing product plus additional attributes which the old product does not have. [3]

Part of the answer to the question why (older) adults do not go by trike lies in the advantages and disadvantages a tricycle has compared to the existing product, an ordinary bicycle.

One potential advantage of a tricycle might be more safety. The majority of crashes cyclists experience in traffic are single bike crashes, i.e. falls or collisions with stationary objects. These crashes have less severe consequences than collisions with motor vehicles [1] but their sheer number makes them a challenge for traffic safety. Typical causes of single bike crashes are defects in the road surface (potholes), kerbs and insufficient (winter) maintenance of the paths [4]. For older road users, crashes have more severe consequences than for younger road users because older persons are physically more vulnerable than younger persons [5]. A second potential problem for older cyclists lies in the fact that physical difficulties make cycling more difficult for older persons: turning around before an off-side turn, stepping on and off the bike, and keeping balance [6]. Dealing with defects in the road surface also calls for considerable skills. Handling these problems might be easier when cyclists with physical problems use a tricycle instead of a bicycle but – as can be seen on the roads – this option is chosen by a very small minority of older cyclists.

On the basis of this assumption that tricycles might be technically safer for persons with physical problems one might consider information on the benefits of tricycles to be useful or necessary in order to make them more popular. Do persons who ride a bicycle consider tricycles to be **safer** than a bike? Even if safety benefits are expected, what disadvantages are expected when one rides a tricycle instead of a bicycle? Does experience change this perception – for the better or even for the worse?

The prominent advantage of tricycles compared to bicycles is that they need less balance. A trike rider does not need as good motor skills as a bike rider, and the rider is less likely to fall because of a defect in the surface. Do cyclists perceive this advantage?

On the other hand various potential disadvantages might be expected from the "new" product tricycle:

To the extent that a cycling **infrastructure** exists in Germany, it is built according to the needs of bi-cyclists, cyclists on two-wheel cycles. As space is scarce in towns and broader infrastructure is more expensive, cycle paths are often not built as wide as the standard measures [7] but only as wide as the minimum width. Such an infrastructure is not inviting for any cycle which is broader or longer than an ordinary one: child trailers, tandems, recumbents, tricycles, and other unusual cycles. Bicyclists can often use small and narrow paths as shortcuts. Street furniture elements which are installed to keep out cars or motor cycles sometimes also prevent cyclists from using such narrow paths. For this reason persons on tricycles sometimes have to make detours and have to find different routes than those they could use on an ordinary bicycle.

Tricycles are **heavier and bulkier** than ordinary bicycles. Carrying them might be a problem for most persons, especially for those who might profit from their safety most, persons with physical problems. This means that parking them at night in a cellar is usually not an option. The weight is a disadvantage when cycling uphill. From the bulky appearance of tricycles, non-users might infer that they are more difficult to steer. Other aspects of handling a tricycle might also be seen as more or less difficult, like for example getting on or off the vehicle, in normal use or if an accident is imminent.

Persons cycling on any kind of special bike are often **looked at and talked to**. Recumbent cyclists experience a range of non-verbal reactions from pure astonishment to laughter. There is a large range of comments like "Don't fall asleep!", "You looks like you're at the gynecologist's". Questions are sometimes serious, sometimes not: "Can I try this bike?", "How much did it cost?", "Does it go fast?" Finally, a small number of persons are really interested and ask for information on advantages and disadvantages, availability and various other aspects. Persons on tricycles might have similar experiences, perhaps modified by the assumption that the cyclist using it is handicapped.

Basically two types of tricycles exist: Tricycles with an ordinary saddle and an upright sitting position, just like an ordinary bike, and recumbent tricycles. Recumbents are lower than ordinary cycles, but their height varies considerably. The **overview** a recumbent cyclist has in traffic varies very much with his or her eye height. Bi- and tricycles with an upright sitting position often allow a good overview in traffic because the cyclists' eye height is above the roof of many cars. Recumbent cyclists are often addressed with the question as to how much they can see and how well they are seen by car drivers. For this reason it can be expected that the eye height and the lower sitting position might be seen as a disadvantage of recumbent cycles. The centre of gravity of a recumbent trike is lower than the centre of gravity of a trike with an upright sitting position. For this reason keeping balance on recumbent trikes is even less of a problem.

The presented online study intended to find out what the image of tricycles in Germany is. Are tricycles expected to have safety benefits compared to bicycles? Which advantages and disadvantages are expected when a cyclist switches from bi- to tricycling? Can infrastructure (cycle paths and small paths) be used as easily? What about handling the bike in traffic and when getting on and off? To what extent is parking the bike safely at night considered to be a problem? Tricycles are less common than bicycles. How much attention do they attract? Two types of tricycles might be used for the same purposes as bicycles, upright and recumbent tricycles. Are there practically relevant differences between the images of these two types of tricycles?

How far are the expectations of persons who do not ride a tricycle in everyday traffic shared by those who ride a tricycle? This information might indicate which expectations might be altered by experience.

2 METHODS

2.1 Questionnaire

An online survey was programmed and presented on the platform http://soscisurvey.de/ from August 1st to October 7th 2013. Only adults living in Germany were addressed. The questionnaire contained an introduction, asked for general attitudes towards older cyclists, what is important for the participants when buying a cycle ("Fahrrad" which means bi- as well as tricycle), and assessed demographic data. Furthermore, the participants were asked to compare tricycles to an ordinary bicycle. Only this part of the questionnaire is analysed here. The participants were introduced to the two types of trikes relevant for the subsequent questions: (a) a recumbent tricycle with a relatively high sitting position and (b) an ordinary tricycle. For each type of trike, a picture was presented[1]. Figure 1 shows these pictures.

[1] J. Krause had asked all German tricycle manufacturers of whom we knew for pictures of their tricycles for the survey. Our intention was to present pictures of a variety of tricycles as examples. One manufacturer each of ordinary and recumbent tricycles responded almost immediately, and positively. All other reactions took at least two weeks; by this time, programming the survey had been completed. For this reason we chose the two examples which had been made available within our time frame. We would like to thank Maxirad and HP Velotechnik for providing us with the pictures.

Figure 1. Pictures of the ordinary (upright) and recumbent tricycles presented in the survey.

For each type of trike, several aspects of availability and contact were assessed on a five-point rating scale. Then this type of trike was compared to an ordinary bike with a two-sided slider without marks. (The endpoints of the slider were internally coded as 1 and 100, the internal mean value where the slider was positioned before the rating was 50.5.) Finally, questions on symbolic aspects of this type of trike were assessed on a five-point rating scale. Participants were asked for the assumed price of the trike and its evaluation.

In about half of the questionnaires the block with questions about the ordinary tricycle was presented first; in the other half the block with the recumbent tricycle came first. In about half of the questionnaires the bicycle was presented on the left hand side; in the other half on the right hand side. The two sequences of trike types and the two arrangements of bike and trike resulted in four questionnaire versions with sequence and presentation side counterbalanced: recumbent trike first – trikes on left hand side, recumbent trike first – trikes on right hand side, ordinary trike first – trikes on left hand side, ordinary trike first – trikes on right hand side. The programme chose the version to be presented at random.

2.2 Participants

The survey was presented in newsgroups and blogs related to cycling, traffic or seniors. The German bicycle club (ADFC), Human Powered Vehicles Germany and the bicycle forum of the German Federal Ministry of Transport, Building and Urban Development (http://www.nationaler-radverkehrsplan.de) put links on their websites. The survey was announced in the free cycling journal Fahrradzukunft and in journals and newsletters of sections of the German bicycle club, the bicycle forum of the German Federal Ministry of Transport, Building and Urban Development, Verbund Service and Fahrrad, and probably other groups. The information was also e-mailed to the authors' contacts. Non-cyclists were also expressly addressed but – as expected – the topic was more interesting for persons who cycle relatively often.

2.2.1 Exclusion of data sets.

Only persons who had answered the questionnaire at least until they reached the last page, where they could submit a free-form comment, were included in the analysis. Five persons who had stated that the price of a tricycle was between 0 and 42 Euros were excluded as we had to assume that they had not taken the questionnaire seriously.

The results of the survey might be influenced by the quality of cycling infrastructure and by the image of tricycles and recumbents in different countries. For this reason it was decided to address only persons living in Germany; versions for Switzerland and Austria exist but their results are not reported here because they have not yet been advertised enough. As a consequence of the decision to address only persons living in Germany, eleven persons who had not

marked a Bundesland as their place of residence were excluded from the sample. The remaining sample consisted of 1194 persons.

2.2.2 Partitioning of subsamples.

The number of participants who owned tricycles was surprisingly high. This allows us to compare the opinion of persons who owned a tricycle and persons who did not own a tricycle. Ten persons owned neither a bicycle nor a tricycle; the answers of eight persons did not allow us to infer whether they owned a bike or a trike or both (e.g. "Lastenrad", which might be a cargo bike or a cargo trike). These persons were excluded from the analysis.

The remaining large sample of 1168 persons with bi- and tricycles (925 with a two-wheeler only, 45 with a three-wheeler only, and 198 persons with a two- and a three-wheeler) allowed us to run the analysis of expectations towards tricycles on a subsample of persons who only owned bikes with an upright sitting position, which are not longer than ordinary bikes and not very conspicious in traffic. Owners of cargo bikes, two-wheeled recumbents or tandems were excluded from this group. These persons were the intended target group of the survey. Some of them owned a folding bike, which is not "ordinary" in the strict sense of the word, but it does not need more space in traffic, nor does it attract very much attention.

The number of persons owning ordinary ("upright") tricycles was too small to allow a comparison between expectations and experiences. This was different for recumbent tricycles. Here, it was possible to compare expectations of non-riders and expectations of riders. The experienced persons who are able to compare ordinary bikes and recumbent trikes are persons who owned an ordinary two-wheel bike and a recumbent trike. To what extent the view of velomobile owners differs from the view of owners of unfaired tricycles is an empirical question. Velomobiles are still heavier, broader, longer and attract more attention than unfaired trikes. As a precaution against extreme judgements, velomobile owners were not included in the experienced group.

2.2.3 Demographic characteristics and cycling habits of the participants.

Table 1. Gender, driving licence, car availability of the participants per group

	Ordinary bike only		*Experienced*	
	N (of 754)		*N (of 138)*	
Proportion women	*741*	*27%*	*133*	*7%*
Driving licence	*745*	*93%*	*137*	*96%*
Car at disposal	*748*	*68%*	*136*	*85%*
Member German cycle club (ADFC)	*754*	*33%*	*138*	*38%*
Member Human Powered Vehicles	*754*	*0%*	*138*	*16%*

Table 2. Age of the participants per group.

Age (years)	*Ordinary bike only (N= 754)*	*Experienced (N= 138)*
Mean	*43.37*	*47.38*
Median	*44.00*	*46.50*
Standard deviation	*15.171*	*9.860*
Minimum	*18*	*24*
Maximum	*83*	*74*

Table 1 shows the gender distribution and the proportions of persons with a driving licence and a car at their disposal per group. Table 2 shows the age distribution, Table 3 the duration of education, Table 4 the cycling frequency, and Table 5 the cycling purposes of the participants per group. The sample consisted mainly of persons who cycle often and for a number of purposes. The level of education of the sample was relatively high.

Table 3. Education of the participants per group.

	Ordinary bike only (N= 749)	*Experienced (N= 138)*
Finished school after 8 years	*2.1%*	*1.4%*
Finished school after 9 years	*1.6%*	*5.1%*
Finished school after 10 years	*8.0%*	*8.0%*
Vocational diploma or university entrance diploma	*26.0%*	*21.7%*
University degree	*62.2%*	*63.8%*

Table 4. Cycling frequency of the participants per group.

	Ordinary bike only (N= 754)	*Experienced (N= 138)*
Daily or almost daily	*61.7%*	*60.9%*
3-4 times a week	*18.4%*	*26.1%*
1-2 times a week	*10.6%*	*10.9%*
1-2 times a month	*4.8%*	*2.2%*
Less than 1-2 times a month	*4.5%*	*0.0%*
Never	*0.0%*	*0.0%*

Table 5. Destinations and cycling purposes of the participants per group.

	Ordinary bike only (N= 754)	*Experienced (N= 138)*
Cycle to work	*68%*	*78%*
Cycle to friends/family	*74%*	*75%*
Cycle for errands: shopping, doctor, ...	*85%*	*86%*
Cycle for day trips	*69%*	*83%*
Cycling holidays	*46%*	*61%*
Cycle for leisure purposes	*79%*	*88%*
Cycle for sports training	*37%*	*46%*

3 Results

All analyses were carried out with SPSS 21.0.0.1.

In the items where bicycle and tricycle were compared, the sliders were positioned in the middle at first. They only slightly changed colour when they had been touched or moved. The questionnaire contained an instruction on the sliders but this instruction was not as effective

as intended. In some items, there was a huge proportion of missing values (0.4% to 26.5%, a median of 8.0%), mainly in those comparisons where the mean value of the remaining sample was close to the middle position. It is not clear whether in these cases the participants had no opinion or considered bicycle and tricycle as equal in this dimension.

The comparison judgements are assumed to be on an ordinal scale. This means that they cannot be tested for deviation from a mean value. Instead we tested whether ratings above and below the mean value were of equal frequency. This hypothesis could be rejected for all ratings. This means that, in all aspects, differences between an ordinary bike and both types of trikes were found. Considering the large samples and the large number of comparisons, a significance level of $p \leq .001$ was chosen.

3.1 Ordinary and recumbent tricycles compared to ordinary bicycles.

Figure 2 shows which differences persons who cycle ordinary bikes expect between bicycles and tricycles in terms of handling and comfort. Tricycles are less easy to handle: they are heavier; they are more difficult to steer; they need more pedalling power. Tricycles are more comfortable than an ordinary bike. The recumbent trike is more difficult to get on and off, in general and if an accident is imminent. The ordinary trike is easier to get on and off than a bike in general, but more difficult if an accident is imminent. Trikes are ranked as better than a bike in terms of preventing the rider's clothes from getting dirty.

Figure 2. Comparison of bike and trike: Median ratings of handling and comfort (*N*=754 persons riding ordinary bicycles).

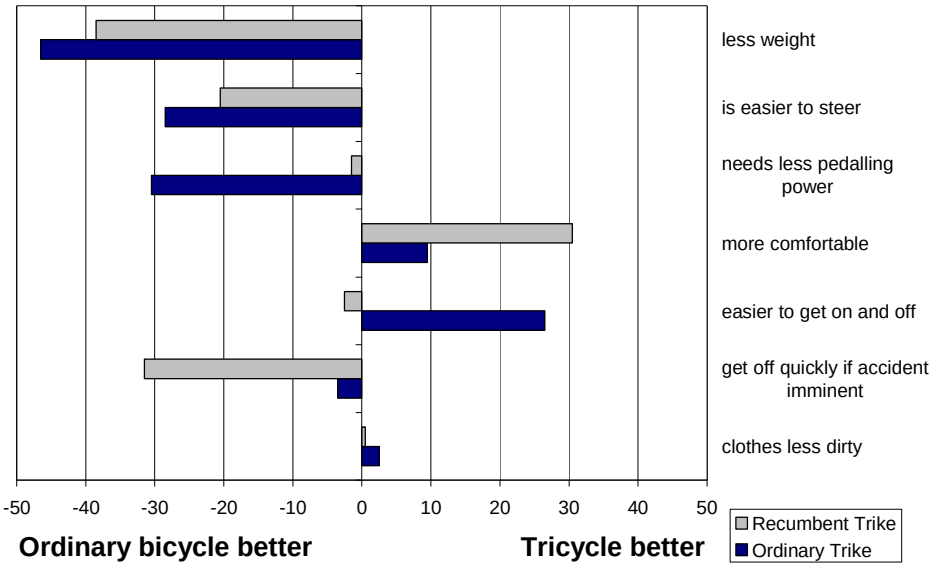


Figure 3 shows expectations regarding how well cyclists can use different kinds of infrastructure with bi- and tricycles. Both types of tricycles need more space on the road and cannot be cycled on bike paths and bypaths as easily as bicycles. Ordinary tricycles cannot be ridden as fast as bicycles, recumbent tricycles faster.

Figure 3. Comparison of bike and trike: Median ratings of infrastructure and speed (*N*=754 persons riding ordinary bicycles).

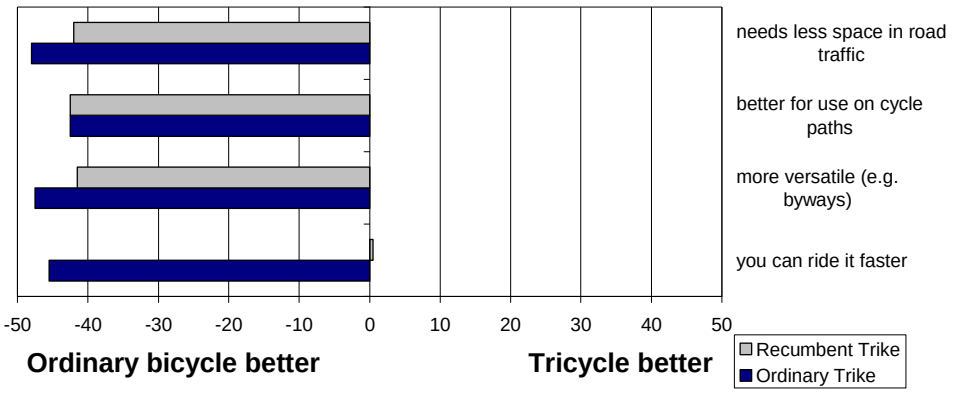


Figure 4 shows the expected difference between bi- and tricycles in terms of their safety. Ordinary tricycles are seen as somewhat safer and less prone to accidents than ordinary trikes. In these two aspects recumbent tricycles do not differ from ordinary bicycles. On both types of tricycles it is easier to keep one's balance. Recumbent trikes are less easily visible to car drivers; ordinary trikes are easier to see. The recumbent tricycle allows a worse overview in traffic than a bicycle; the ordinary trike provides an overview just like an ordinary bike.

Figure 4. Comparison of bike and trike: Median ratings of safety (*N*=754 persons riding ordinary bicycles).

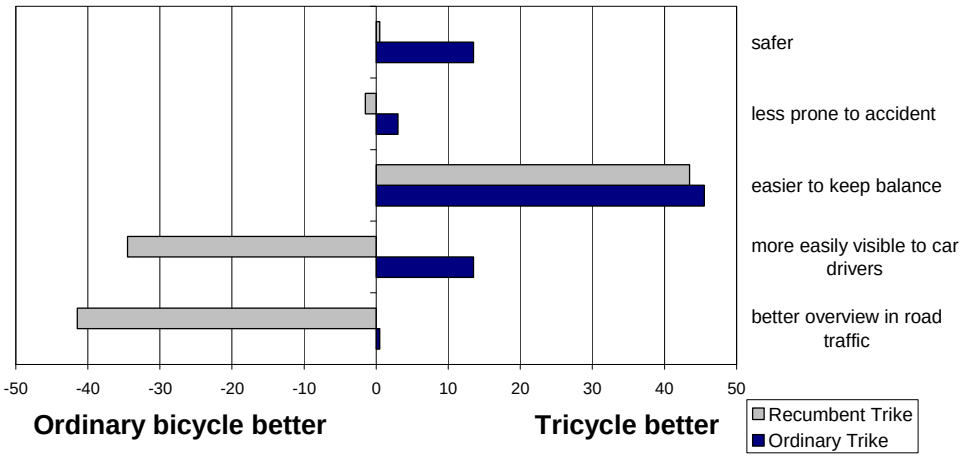
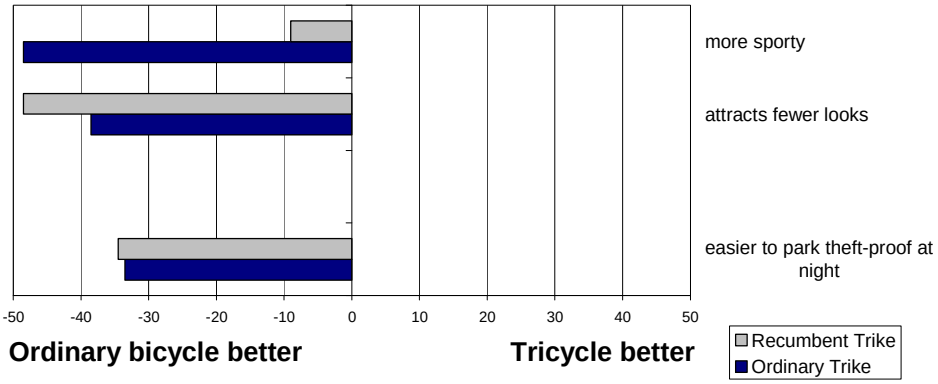


Figure 5 shows the answers to the questions on image and night parking. The recumbent tricycle is considered as somewhat less sporty than an ordinary bike, the ordinary tricycle as much less sporty. Both tricycle types attract a lot more looks than an ordinary bike. Both tricycle types are less easy to park theft-proof at night than an ordinary bike.

Figure 5. Comparison of bike and trike: Median ratings of image and parking at night (*N*=754 persons riding ordinary bicycles).



3.2 Expectations of riders of ordinary bicycles compared to experiences of riders of recumbent tricycles.

Figure 6 shows the ratings of handling and comfort by persons who ride ordinary bikes and by the experienced persons. In some ratings there is no difference between the groups: Weight, necessary pedalling power, the ease of getting on or off the bike and how well the recumbent tricycle prevents one's clothes from becoming dirty. Compared to persons who only ride ordinary bikes, experienced persons rate a recumbent as easier to steer, as more comfortable and they think that one can get off the recumbent trike more quickly if an accident is imminent.

Figure 6. Ratings in the groups without and with experience: Handling and comfort (*N*=452 persons riding ordinary bicycles only and *N*=75 persons owning a recumbent tricycle and an ordinary bicycle). Significant differences ($p \leq .001$) between the groups are marked with an asterisk.

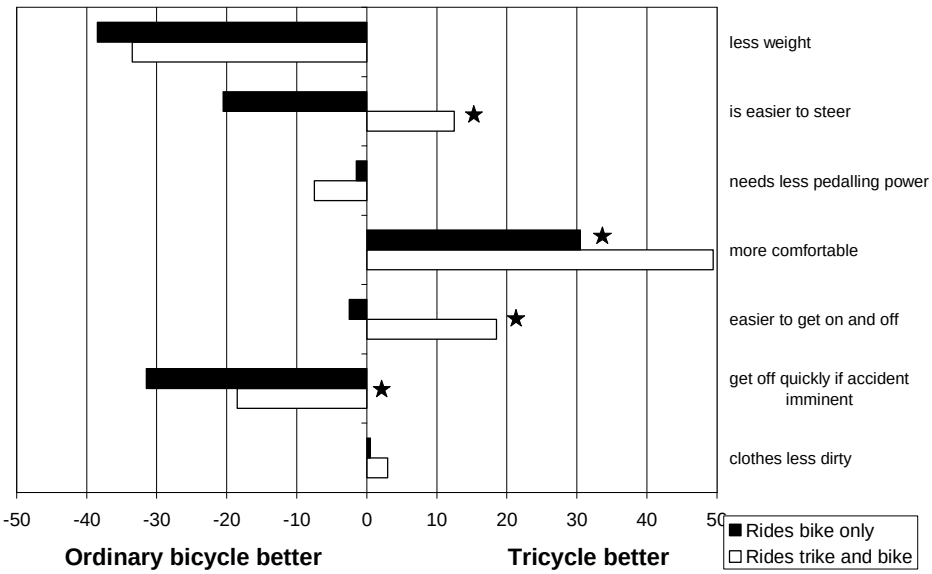


Figure 7 shows the ratings of infrastructure use and speed by persons who ride ordinary bikes and by experienced persons. The groups do not differ in their ratings regarding the recumbent tricycle being worse for use on cycle paths and regarding the relative speed of recumbent tricycles. Both groups think that a recumbent trike needs more space in traffic than an ordinary

bike and that it can not be used so well on byways; experienced persons rate both differences between recumbent trike and ordinary bike as smaller.

Figure 7. Ratings in the groups without and with experience: Infrastructure and speed (*N*=452 persons riding ordinary bicycles only and *N*=75 persons owning a recumbent tricycle and an ordinary bicycle). Significant differences (p ≤ .001) between the groups are marked with an asterisk.

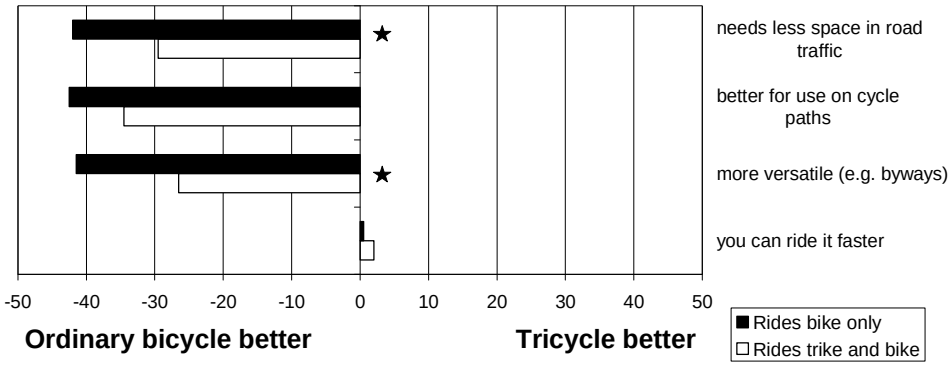


Figure 8 shows the ratings of safety by persons who ride ordinary bikes and by experienced persons. Ease of balance is the only rating in which the two groups do not differ. In all other safety ratings experienced persons are more positive than persons who ride ordinary bikes.

Figure 8. Ratings in the groups without and with experience: Safety (*N*=452 persons riding ordinary bicycles only and *N*=75 persons owning a recumbent tricycle and an ordinary bicycle). Significant differences (p ≤ .001) between the groups are marked with an asterisk.

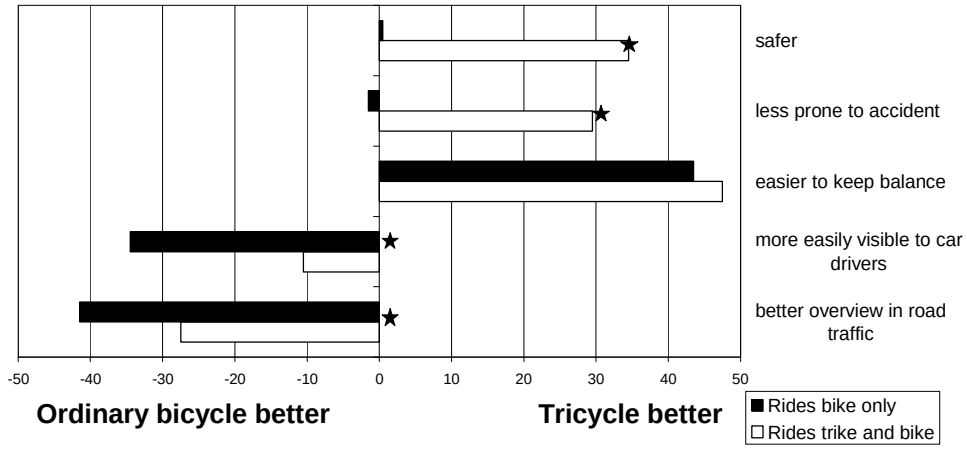


Figure 9 shows the ratings of image and parking by persons who ride ordinary bikes and by experienced persons. Experienced persons see recumbent trikes as more sporty. Both groups think that a recumbent trike attracts more looks than an ordinary bike. Experienced persons think that the difference between a bike and a trike is even greater. Both groups think that a recumbent trike is less easy to park theft-proof at night than an ordinary bike.

Figure 9. Ratings in the groups without and with experience: Image and parking at night (*N*=452 persons riding ordinary bicycles only and *N*=75 persons owning a recumbent tricycle and an ordinary bicycle). Significant differences (p ≤ .001) between the groups are marked with an asterisk.

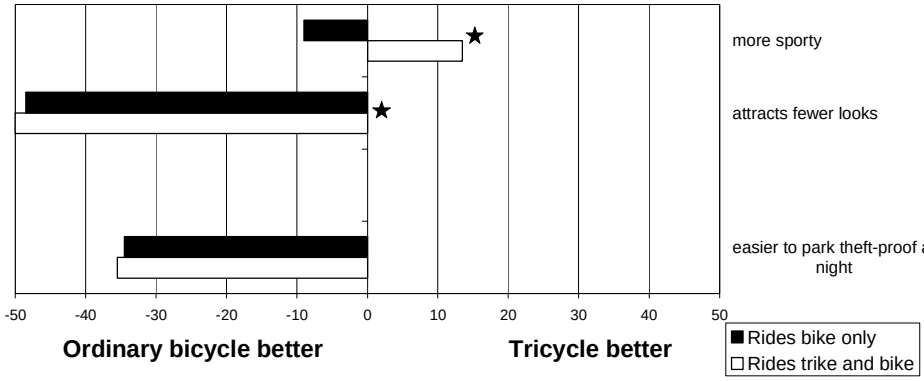


Table 6. Correlations (Spearman rho) between the ratings of relative safety (recumbent trike compared to ordinary bike), age and gender with the other ratings for recumbent trikes.

	Ordinary bike only (N 572 to 744)				*Experienced (N=96 to 115)*	
	age	*gender*	*safer*	*less prone to accident*	*safer*	*less prone to accident*
age (years)		***-.25****	***.21****	*.11**	***.30****	*.11*
gender	***-.25****		*-.05*	*.04*	*-.09*	*-.09*
safer	***.21****	*-.05*		***.55****		***.68****
less prone to accident	*.11*	*.04*	***.55****		***.68****	
less weight	***-.13****	*.09*	*.00*	*.06*	*.01*	*-.06*
easier to steer	*.11*	*-.08*	***.29****	***.29****	***.48****	***.41****
needs less pedalling power	*.01*	*-.04*	*.04*	*.04*	*.27*	*.16*
more comfortable	*.04*	***-.13****	***.21****	***.14****	***.46****	*.27*
easier to get on and off	***.12****	*-.06*	***.23****	***.26****	***.32****	*.18*
get off quickly if accident imminent	*-.01*	*-.04*	***.26****	***.21****	*.28*	*.12*
clothes less dirty	*-.03*	*-.10*	***.14****	***.17****	***.46****	***.36****
less space in road traffic	*-.04*	*-.02*	*.09*	*.11*	*-.06*	*-.13*
better for use on cycle paths	*-.11*	*.03*	*.08*	*.09**	*-.02*	*-.01*
more versatile (e.g bypaths)	*-.02*	*.01*	***.14****	***.14****	*.19*	*.17*
you can ride it faster	***.14****	***-.14****	*.11*	*.02*	*.26*	*.16*
easier to keep balance	*.04*	*-.06*	*.06*	*.02*	*.26*	*.08*
more easily visible to car drivers	*-.02*	*.01*	***.29****	***.31****	***.40****	***.34****
better overview in road traffic	*-.02*	*-.00*	***.23****	***.27****	*.18*	*.12*
more sporty	*-.00*	*-.05*	*.13*	*.08*	*.14*	*.20*
attracts fewer looks	*.02*	*-.03*	*.03*	*.02*	***-.42****	*-.27*
easier to park theft-proof at night	*-.07*	*.06*	*.04*	*.07*	*-.01*	*-.04*

Note. Significant Spearman correlations (p ≤ .001, 2-tailed) are marked with an asterisk and printed bold.

Table 6 shows the rank correlations (Spearman rho) of age and gender of the raters, the safety ratings and all other ratings for recumbent tricycles in both groups, riders of ordinary bikes and experienced riders. The advantage in the ease of keeping balance is unrelated to safety advantages in both groups. The rating regarding a recumbent tricycle being easier to steer is related to a safety advantage in both groups. Being seen by car drivers is related to safety and lower accident proneness in both groups; a better overview only in the group of riders of ordinary bikes. Ease of getting on and off the recumbent trike in normal use and if an accident is imminent is related to perceived safety in the group of riders of ordinary bicycles. In both groups the advantage of getting clothes less dirty is related to safety advantages. Comfort rating and safety are correlated in the group of riders of ordinary bicycles, and there is a tendency in the same direction in the experienced group. Riders of ordinary bikes who think that a recumbent can better be used on bypaths rate it as safer. In the groups of riders of ordinary bikes and experienced riders older persons rate recumbent trikes as safer than younger persons.

3.3 Attitudes towards older cyclists

Table 7 shows the ratings on statements about older cyclists. Both groups have positive attitudes towards older cyclists. Experienced recumbent cyclists agree to a larger extent with the statement that a tricycle is a way for the elderly to maintain their mobility. They report that they have more often advised an elderly friend to switch to a tricycle.

Table 7. Median ratings for statements about older cyclists by riders of ordinary bikes and experienced riders.

	Riders of ordinary bicycles (N=748 to 751)	*Experienced riders (N=136 to 137)*
A tricycle is a way for the elderly to maintain their mobility.	*4*	*5*
A tricycle is a way for the elderly to maintain their independence and self-reliance in terms of mobility.	*4*	*4*
A tricycle is a practical aid for the elderly.	*4*	*4*
If you're starting to lose control of your bicycle, you should switch to a tricycle.	*2*	*1*
Elderly bicyclists should switch from bicycles to tricycles.	*3*	*3*
I have already advised an elderly friend to switch to a tricycle.	*1*	*4*

Note. Ratings were given on a 5-point scale from 1 = not at all true to 5 = absolutely true.

4 CONCLUSIONS

There is a simple answer to the question "Why don't they go by trike?", namely: "Why should they?" Compared to ordinary bicycles, tricycles are expected to have huge disadvantages but only some minor advantages. Persons who ride a recumbent tricycle and an ordinary bike see the recumbent tricycle as more positive in general but not in all aspects.

4.1 Potential safety benefits of tricycles?

Persons who ride ordinary bicycles expect that ordinary tricycles are slightly safer and slightly less prone to accidents than ordinary bikes, but they do not expect the same advantages from recumbent tricycles. Experienced persons expect a safety advantage from recumbent tricycles. Recumbent riders not only experience a lot of attention on the road but many of them also advise elderly friends to switch to a tricycle. However, as their absolute number is relatively low they can only provide relatively few persons with the necessary information.

In general, it is assumed that it is easier to keep balance on a tricycle. Surprisingly, this perceived advantage is unrelated to perceived safety benefits. This result can be found in the groups of riders of ordinary bikes and experienced riders. In both groups, ease of steering a tricycle is related to safety perception. Inexperienced riders expect it to be more difficult to steer a recumbent trike than an ordinary bike; experienced riders expect it to be more easy to steer.

In the groups of experienced and inexperienced riders, safety advantages are related to the rating of how easily a cyclist can be seen by car drivers, and partly to the rating of how good the cyclist's overview in road traffic is.

This shows that safety perception is more closely related to interaction with other road users, mainly car drivers, but not to keeping balance. One can assume that the relative frequency of single-bike crashes [1] is unknown to the majority of cyclists.

4.2 Disadvantages of tricycles

The weight and width of tricycles make handling them more difficult. They need much more space in traffic than ordinary bikes, not all bypaths can be used with them, and they can be less easily used on cycle paths. The latter statement points to a potential problem concerning traffic safety. Many cyclists in Germany think or feel that cycling on a bike path is much safer than cycling on the road together with motor vehicles. 85% of car drivers and cyclists in Germany share the false assumption that cyclists always have to use a cycle path if one exists. [8] If no bike path is available, some cyclists use the footpath instead. On the footpath at intersections and exits, cyclists run a relatively high risk of a crash with a car driver who does not expect cyclists to be there [8]. For this reason it has to be made clear for all road users that, whenever no cycle path exists or the cycle path is not suitable to be used by tricycles, tricycle riders have to ride on the road. In Germany, an administrative regulation exists that persons with tricycles and bike trailers who cycle on the road should as a rule not be addressed by the police [9], but at present the abolition of this administrative regulation is under discussion. [10]

For the problem of tricycle parking, technical solutions have to be found for cyclists who have no garage and no other theft-proof parking facility. Small bi- and tricycle garages might help not only persons with tricycles but also other cyclists who have trouble carrying their bike up- or downstairs.

Ratings of handling and comfort might be changed by test rides. Not many opportunities for test rides exist if cyclists do not want to go to a bicycle exhibition or a similar event. How they influence the perception of handling and comfort is a question which can be answered by empirical studies. This cross-sectional study cannot rule out the possibility that the difference between riders of ordinary bicycles and experienced riders has other causes than just their relative levels of experience with recumbents.

It is not clear to what extent the results of this study are representative for the opinion on tricycles in Germany. This study was announced and advertised as a study on tricycles. For this reason it can be assumed that the participants were relatively open to this topic. There is no reason to assume that the opinion of the general public in Germany is more in favour of tricycles than the results of this study show. Much effort is required if one wants to change the image of tricycles so much that they become an attractive mobility option for adults.

REFERENCES

[1] P. Schepers, N. Agerholm, E. Amoros, R. Benington, T. Bjørnskau, S. Dhondt, B. de Geus, C. Hagemeister, B. P.Y. Loo and A. Niska "An international review of the frequency of single-bicycle crashes (SBCs) and their relation to bicycle modal share", in press.

[2] M. R. Solomon, G., Bamossy and S. Askegaard (Eds.), *Konsumentenverhalten: der europäische Markt [Consumer behaviour: The European market].* Pearson Studium, München, 2001.

[3] A. Kuß and T. Tomczak, *Käuferverhalten: eine marketingorientierte Einführung [Buyers' behaviour: a marketing oriented introduction]*. Lucius & Lucius, Stuttgart, 2007.

[4] P. Nyberg, U. Björnstig and L.-O. Bygren, "Road characteristics and bicycle accidents." *Scandinavian Journal of Social Medicine* **24** (1996), pp. 293-301.

[5] R. Welsh, A., Morris, A. Hassan and J. Charlton, "Crash characteristics and injury outcomes for older passenger car occupants", *Transportation Research Part F* **9** (2006), pp. 322-334.

[6] U. Steffens, K. Pfeiffer and N. Schreiber, N. *Ältere Menschen als Radfahrer [Elderly bicyclists]*. Bericht der Bundesanstalt für Straßenwesen, M112. Bremerhaven, 2000.

[7] Forschungsgesellschaft für Straßen- und Verkehrswesen. Arbeitsgruppe Straßenentwurf (Ed.), *Empfehlungen für Radverkehrsanlagen (ERA), Ausgabe 2010 [Recommendations for cycling infrastructure, edition 2010]*. Forschungsgesellschaft für Straßen- und Verkehrswesen, Köln, 2010.

[8] H. Kolrep-Rometsch, R. Leitner, C. Platho, T. Richter, A. Schreiber, M. Schreiber, and Petra Butterwegge. *Abbiegeunfälle Pkw/Lkw und Fahrrad [Turning off accidents between motor vehicles and cyclists].* Gesamtverband der Deutschen Versicherungswirtschaft e. V. Forschungsbericht Nr. 21. (2013). Retrieved October 30, 2013 from http://udv.de/ download/file/fid/6918

[9] Verwaltungsvorschrift zur StVO [Administrative regulation concerning the German Road Traffic Act], Rand-Nummer 23 zu § 2 Abs. 4 S. 2 bis 4 StVO Retrieved October 30, 2013 from http://www.verwaltungsvorschriften-im-internet.de/bsvwvbund_26012001_S32364 20014.htm

[10] Entwurf der Studie Praxisfragen und Probleme im Zusammenhang mit der Regelung der Benutzungspflicht von Radverkehrsanlagen FE 77.0487/2006 für das BMVBS, Stand Mai 2013. (unpublished)