Article

More Cycling, Less Driving? Findings of a Cycle Street Intervention Study in the Rhine-Main Metropolitan Region, Germany

Andreas Blitz *[ID], **Annika Busch-Geertsema**[ID] **and Martin Lanzendorf**[ID]

Department of Human Geography, Goethe University Frankfurt/Main, Theodor-W.-Adorno-Platz 6,
60629 Frankfurt am Main, Germany; busch-geertsema@geo.uni-frankfurt.de (A.B.-G.);
lanzendorf@geo.uni-frankfurt.de (M.L.)
* Correspondence: blitz@geo.uni-frankfurt.de

Abstract: In order to encourage a shift from the car to the more sustainable transport mode of cycling, cycle streets have been implemented in cities all over the world in the last few years. In these shared streets, the entire carriageway is designated for cyclists, while motorized traffic is subordinated. However, evidence on the impact of cycle street interventions related to travel behavior change has been limited until now. Therefore, the objective of this study was to evaluate whether cycle streets are an effective measure to facilitate bicycle use and discourage car use, thus contributing to the aim of promoting sustainable travel. For this purpose, we conducted a written household survey in the German city of Offenbach am Main involving participants affected by a cycle street intervention (n = 701). Based on two stage models of self-regulated behavioral change (SSBC), we identified the participants' level of willingness to use a bicycle frequently and to reduce car use. By means of bivariate and multivariate statistical methods, we analyzed the influence of awareness, use, and perceptions of the cycle street on the willingness to change behavior towards more sustainable travel. The results show that the intervention has a positive impact on frequent bicycle use, while we observed only a limited effect on car use reduction. Traffic conflicts and car speeding within the cycle street adversely affect the acceptance of the intervention. The study's findings provide new insights into the actual effects of a cycle street and its potential to encourage sustainable travel behavior.

Keywords: cycle streets; bicycle use; car use reduction; travel behavior change; stage-based models; sustainable travel

1. Introduction

Private car use still dominates everyday travel behavior in many regions of the world [1]. In view of persistent population growth and urbanization processes, urban areas in particular have to face the negative impacts of further increases in individual motorized transport. These include congestion and extensive land use as well as air pollution and traffic noise affecting health [2–5]. Within many cities, the promotion of cycling as a sustainable transport alternative has become an important measure in order to meet these challenges [6–8]. A wide variety of interventions related to infrastructure, regulations, and marketing is being implemented all over the world to increase cycling or reduce car use [1,9–11]. The concept of cycle streets that emerged in several countries within recent years aims to facilitate bicycle use and to discourage motorized traffic at the same time [12–14]. It is therefore an approach counteracting present car dependency by fostering non-motorized alternatives, similar to other environmental developments focusing on the improvement of bikeability or walkability in urban areas involving bicycle paths and footpaths, safe crossings, and aesthetic elements [15–17].

Cycle streets can be defined as shared streets within cities or suburban areas prioritizing cycling by means of certain regulations and design features [16,18,19]. Within a cycle street, the entire carriageway is designated for bicycle traffic, even though in many cases it is shared with motor vehicles. As no standardized guidelines for cycle streets exist, different implementations can be found even within the same country as well as different notions such as "bicycle boulevard", "neighborhood greenway", "bicycle priority street", and "bicycle friendly street" [19,20]. In Germany, "bicycle streets" are specified within its national traffic regulations ("Straßenverkehrsordnung"). According to these, bicycle traffic within cycle streets must not be obstructed or endangered by motorized traffic, which is requested to adapt to the cyclists' speed. The maximum speed is limited to 30 km per hour. Cyclists are allowed to ride alongside each other. Motorized traffic is only permitted to pass through the street if there is an extra permission indicated by an additional traffic sign [21].

Benefits related to the implementation of cycle streets include the establishment of bicycle routes in a cost-effective way without the need for additional space, the enhancement of safety for cyclists, and the potential of shifting from the car to the bicycle [18]. Thus, the intervention of implementing a cycle street refers to a strategy of transportation demand management, which aims for a change in travel behavior in order to foster sustainable, efficient, and affordable mobility [22–24].

The idea of cycle streets emerged in several countries in recent years. Examples can be found in particular within Dutch, Belgian, and German communities and occasionally in Denmark, Sweden, Switzerland, Austria, France, Spain, the USA, and Canada [14]. Despite the increased implementation of cycle streets, until now, research on its impact has been limited to only a small number of cities or streets [25,26] mainly focusing on traffic volume or safety issues. Most commonly, studies relate to the use of a cycle street by cyclists based on traffic volume counts. For instance, the implementation of the first cycle street in Belgium in 2011 resulted in an increase in cyclists within this street of more than 50% within the first few months [27]. Similar evaluations indicating an increase in the street's bike traffic can also be found regarding implementations in Germany [28,29], Switzerland [30], and the USA [31]. By means of GPS monitoring and surveys, some authors point out cyclists' route choice preferences for passing through cycle streets instead of common streets, as these are associated with a higher level of safety and comfort [32,33]. Based on police-reported collision data and cyclist count data, Minikel verifies these associations by identifying lower collision rates for cyclists within cycle streets compared to parallel arterial routes [34].

On the contrary, evaluations of the impacts on car use are even scarcer and provide ambiguous results, indicating no significant decline in car traffic after the implementation of a cycle street [28,30]. Several studies observed a decrease in speed from motorized vehicles [27,35], which is dependent on the specific regulations established within the respective street [30]. Some papers on cycle streets highlight the importance of design measures in terms of reducing traffic speed and discouraging car driving as well as improving acceptability and identifiability, including pavement markings, signs, impediments, and narrowing [19,20,26,36,37].

Further studies on cycle streets concern the acceptance and the awareness of those affected by the intervention. Corresponding studies emphasize that cyclists in particular consider the implementations as an improvement of the street's quality. Moreover, local residents, pedestrians, and even car drivers support the idea of cycle streets in several cases [30,38]. Evaluations of the knowledge of the concept of cycle streets indicate that many of those people passing through the street do not even know exactly which regulations have to be followed [14,28,30].

The review of previous research on cycle streets shows that the intervention's influences on individual processes of travel behavior have hardly been considered. Although findings thus far suggest that cycle street implementations result in an increase in bicycle traffic within the respective street, uncertainty persists as to whether the intervention actually causes more frequent use of a bicycle or if existing cyclists just change their routes in favor of the cycle street. Thus, there is a research gap regarding the effects on individual willingness and intentions to change previous bicycle use and car

use. Furthermore, the impact of perceived characteristics of the implementation, such as identifiability and emerging traffic conflicts, needs further examination.

Therefore, the aim of this paper was to investigate whether the implementation of cycle streets triggers travel behavior change and thus contributes to the objective of fostering sustainable transport within urban areas. As the intervention involves the promotion of cycling and the discouragement of car use, we focused on both modes of transport, questioning the effects on the willingness to increase bicycle and reduce car use.

For this purpose, we conducted a written household survey (n = 701) in two neighborhoods within the city of Offenbach am Main situated in the Rhine-Main metropolitan region in Germany. In one of these neighborhoods (the "Senefelder" neighborhood), a cycle street was implemented six months earlier. There is no cycle street within the nearby reference neighborhood. To determine the effects of the cycle street, we compared the survey data of the two neighborhoods considering the awareness, the use, and the individual perceptions of the intervention as well as bicycle and car related behavior and attitudes.

In order to evaluate possible changes in travel behavior, we employed the stage model of self-regulated behavioral change (SSBC) [39–41], which was developed as part of the intervention evaluation approach "MaxSUMO" [42,43]. By including several factors influencing the intention and the adoption of a certain behavior, the SSBC facilitates assignment to a stage within the processes of voluntarily turning away from previous behavior and adopting an alternative. In recent years, the concept of stage models has been increasingly applied to evaluate the impact of interventions on behavior change (see the review in [44]). With regard to mobility interventions, the reduction of car use in favor of more pro-environmental transport modes, such as cycling or public transport use, has been investigated in particular. Examples include the effects of a marketing campaign for new residents [45], of car reduction policies [46,47], and of a mobility self-assessment app [48]. Yet, to the best of our knowledge, cycle street interventions have not been evaluated based on the SSBC model. As part of this study, we examined several indicators of the cycle street with regard to possible correlations with the SSBC assignments to a stage within the process of behavioral change providing evidence on the behavioral impact of this intervention.

The remainder of this paper is structured as follows. Section 2 addresses the theoretical background to the evaluation of travel behavior change. In Section 3, we describe the case study and the data derived from the survey. Next, results concerning the perception and the use of the intervention, travel attitudes, and behavior as well as the process of behavioral change are presented in Section 4, indicating differences between the two study sample areas, which are discussed in Section 5. The paper ends with conclusions in Section 6.

2. Theoretical Background

Reviews on studies concerning the impacts of bicycle-related interventions point out prevailing uncertainties about the actual effects of specific implementations and policies caused by ambiguities and limitations of the evaluation methods applied [6,11,49–51]. In particular, missing control groups and the neglect of individual perceptions and processes of behavior have been identified as shortcomings of previous research. Thus, several authors insist on comprehensive analysis instruments in order to assess behavior change possibly suggested by interventions [11,50,52,53].

One such evaluation approach considering the processes of behavioral change due to an intervention is "MaxSUMO" [42]. It involves three main levels of intervention evaluation indicators concerning the perception and the use of the mobility management service provided (e.g., a cycle street), the acceptance and the use of the mobility options offered (e.g., mode of cycling), and the overall effects [42,43]. The latter refers to the main outcomes of the mobility intervention characterized by the adaptation of new attitudes and behavior related to mode choice and travel.

The stage model of self-regulated behavior change (SSBC) was developed in order to measure behavioral changes [39,42,45,54]. In accordance with its predecessor model—the "transtheoretical

model" by Prochaska et al. [55,56]—within the SSBC, the process of voluntary change is described by means of four stages representing different levels of openness and willingness to question current behavior and to adopt an alternative: The stages of (1) "predecision", (2) "preaction", (3) "action", and (4) "postaction" (Figure 1). The presence of certain individual perceptions concerning the previous as well as the new behavior initiate the transition from one stage to another [39,57]. Thus, the model enables analysis related to the two processes of abandoning the old behavior and of turning towards another, pro-environmental one.
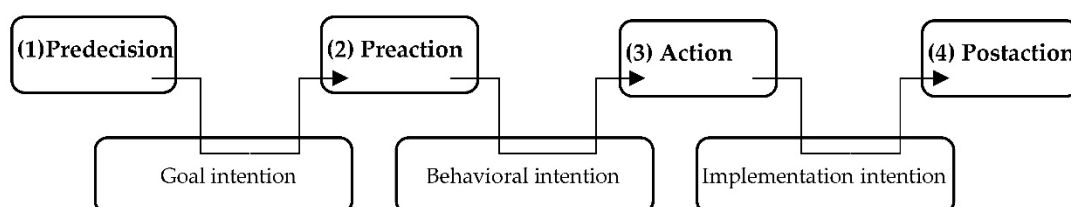

Figure 1. Stages and transitions of the stage model of self-regulated behavioral change (SSBC) (own illustration based on Bamberg 2013 [39]).

In the stage of "predecision", individuals show no preparedness and intentions for change. The transition to the second stage is initiated by the development of an individual "goal intention" indicating the willingness to change previous behavior (e.g., the frequent use of a car). This willingness is induced by obligations to fulfill personal norms [58], by positive associations with and the perceived feasibility of abandoning previous behavior [57]. The second stage ("preaction") involves the evaluation of alternative behavior by means of related perceived behavioral control over the alternative as well as attitudes towards this behavior [59]. The latter refers to the expected outcomes evoked by the behavior, which—when considered positively—strongly encourage the "behavioral intention" [40,41,60]. Next, individuals in the stage of "action" are characterized by the strong intention to replace previous behavior with the evaluated alternative. The prerequisites indicate the willingness and the preparedness for behavior change and that explicit plans or first attempts for implementation exist. The transition to the fourth stage ("postaction") is marked by the regular implementation of the intended new behavior. It involves the maintenance of a new habit, resulting in permanent turning away from previous behavior and adopting the alternative. Although the model constitutes a sequence of stages, the process of behavior change is not necessarily linear. Individuals might remain in a certain stage or even return to a previous one [45].

Within previous studies, researchers have applied various approaches for operationalizing the assignment of individuals to a certain stage of behavioral change, involving variables related to individual intentions, attitudes, and actual behavior. Within several studies, the frequent use of an alternative transport mode (e.g., at least once a week or daily) was considered as an indicator of assignment to the last stage [46,61,62]. Stated intentions of using alternative transport modes or reducing car use as well as certain attitudes were taken into account to determine the transition to the middle stages of behavior change [41,45,62].

3. Materials and Methods

In order to evaluate the impact of a cycle street intervention, we conducted a written household survey in Offenbach am Main, close to Frankfurt am Main in the Rhine-Main metropolitan region in Germany. In contrast to previous studies on cycle streets and travel behavior, which are most commonly based on traffic counts and monitoring [27,30,32,33], the comprehensive household survey addresses all nearby residents affected by the intervention and provides insights into individual perceptions and willingness for travel behavior change based on the respective questionnaire's items. The selection of Offenbach am Main as a case study was based on the city's recent effort to promote sustainable mobility by means of the implementation of cycle streets. The survey involved participants

of the neighborhood close to the first cycle street intervention, which was implemented in September 2018, as well as residents of a similar reference neighborhood used as a control group. Following the introductions of the case study (Section 3.1) as well as the survey's method and items (Section 3.2), we describe, in detail, the collected data (Section 3.3) specifying the variables used for further analyses.

3.1. Cycle Street Intervention in the City of Offenbach am Main

The population of the case study city of Offenbach am Main is almost 140,000 inhabitants [63]. Like the entire region, the city of Offenbach am Main experienced huge population growth over the past few years (about 17% since 2009) [63,64]. Due to the related increase in car traffic volume causing traffic jams and air pollution, the city is endeavoring to promote sustainable mobility by means of the development of bicycle infrastructures as part of the project "Bike Offenbach". Besides the redesign of intersections and the construction of cycle paths, the project involves the implementation of 9 km of cycle streets within the city between 2018 and 2021 [65]. As part of a cycling route system, the cycle streets are intended to contribute to the provision of a seamless and safe citywide bicycle network, facilitating a shift from car to bicycle use. The project's main objective is an increase in the city's proportion of bicycle mode share, which made up 11% in 2017 [66].

The city's first cycle street was implemented in September 2018 within a section of the street "Senefelderstraße" close to Offenbach central station. Senefelderstraße runs within an inner-city residential area connecting the city center with the city's southern neighborhoods. Despite two nearby multi-lane routes ("Waldstraße" and "Sprendlinger Landstraße"), which are designated for Offenbach's north-south traffic, many drivers pass through Senefelderstraße, turning it into a thoroughfare. Since the implementation of the cycle street, bicycle traffic has been prioritized here, indicating that cyclists are permitted to drive alongside each other and determine the actual speed of traffic (limited to 30 km/h). Only residents are allowed to pass through the street as a car driver. Signs and markings point to the street's special traffic regulations (Figure 2). In addition, the city initiated a communication campaign informing the inhabitants of the surrounding "Senefelder" neighborhood through flyers, events, and an online presence.

Figure 2. Entrance to the cycle street "Senefelderstraße" (photograph taken by Andreas Blitz).

3.2. Survey

The written household survey was conducted in March and April 2019 about six months after the implementation of the cycle street. We invited the residents living at Senefelderstraße and at the adjoining streets—i.e., those residents directly affected by the cycle street (Senefelder neighborhood)—as well as a similar number of residents of a nearby reference neighborhood in the city center to participate (Figure 3). We decided on this reference neighborhood because of its similarity to the Senefelder neighborhood in terms of demographic structure, built environment, centrality, and access to public transport. Within each household, one member of at least 18 years of age was requested to participate.
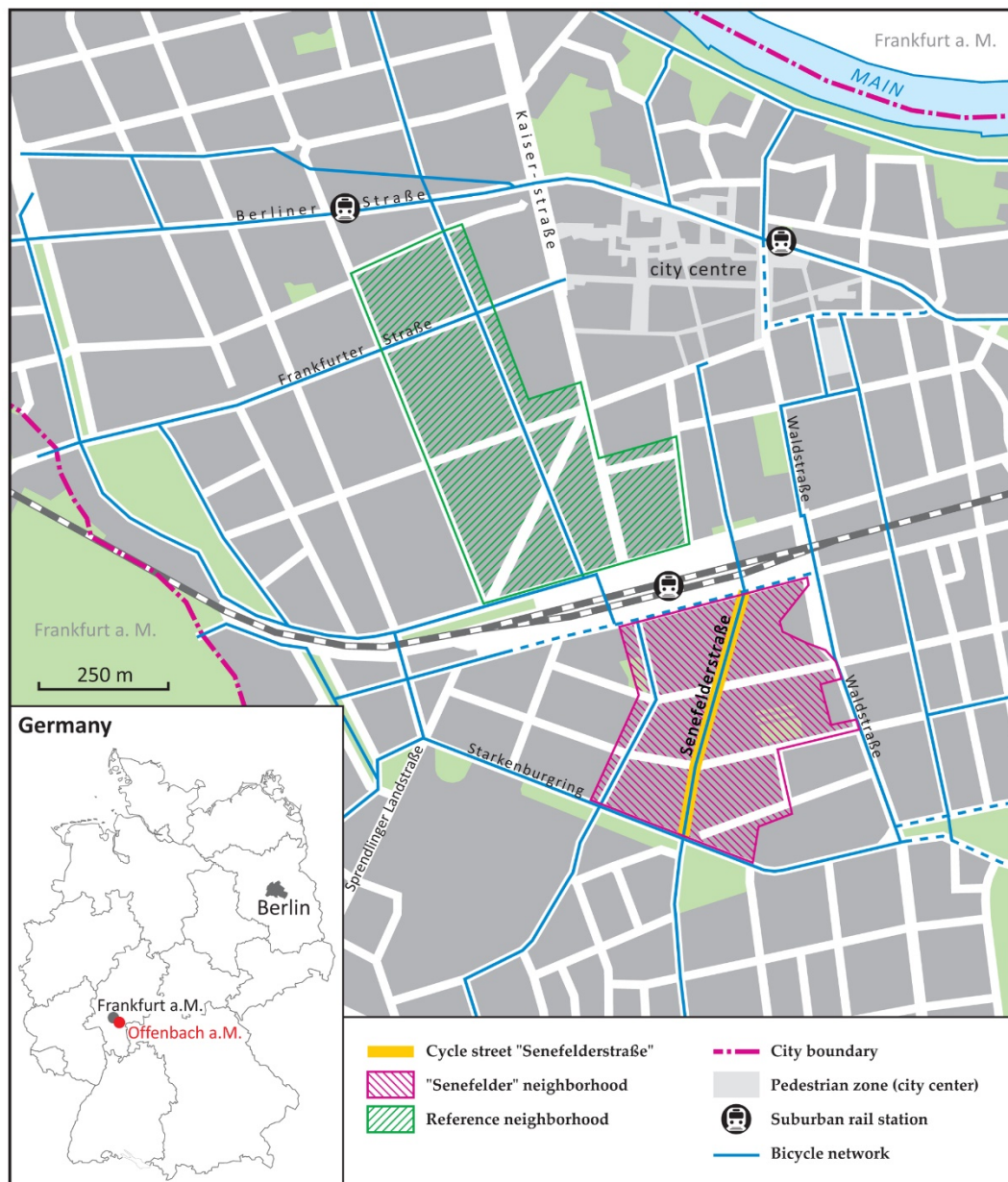

Figure 3. Cycle street of "Senefelderstraße" and the survey areas in the city of Offenbach am Main (cartography by Elke Alban, Goethe-University Frankfurt/Main).

In order to promote participation, the implementation of the survey involved several steps. At first, all of the households (4014) received a written pre-announcement, informing them of the upcoming survey and its subject. One week afterwards, the questionnaires were distributed in letterboxes. These included a cover letter and an envelope allowing the participants to return the questionnaire free of charge. Another week later, the respondents were reminded to participate either by personal contact or, if that was not possible, by leaving a relevant note.

The survey included questions on a respondent's regular travel mode use, travel attitudes and intentions, awareness, use and perceptions of the cycle street intervention, as well as socio-demographics. As far as possible, we applied well-established items already used in previous studies. Questions related to travel mode use corresponded to the comprehensive cross-sectional surveys of "Mobilität in Deutschland" [67]. The constructs for behavioral change stage assignments were developed based on previous studies comprising intentions of using the bicycle more frequently or reducing car use [41,45,46,62] as well as variables referring to perceived behavioral control, personal norms, and attitudes towards the alternative travel option indicating individual willingness and readiness (see Section 2) [39,41,45]. With regard to the perceptions of the cycle street intervention, we created our own specified items, which were pretested for suitability, as was the whole questionnaire.

3.3. Data

The total of 4014 households addressed resulted in 706 questionnaires returned, a response rate of 17.6%. We checked the collected data and rejected questionnaires revealing more than 70% missing values (five cases). Thus, 701 cases remained, of which 365 were from the Senefelder investigation area and 336 were from the reference neighborhood, indicating no significant difference with reference to the response rate of the two investigation areas. By means of multiple imputation, missing values were substituted for bivariate and multivariate analyses [68].

3.3.1. Socio-Demographics and Travel Mode Availability

The socio-demographics of the sample show a good representation of the city's population key indicators except the migrant background (Table 1). The higher average age of the respondents compared to the entire population can be explained by the survey's participation age of at least 18 years. About 75% of the respondents have a high educational entrance qualification. About the same share is in employment or in education, indicating frequent activities. A participant's monthly net income was calculated according to the "OECD-modified" (Organization for Economic Co-operation and Development) equivalence scale involving household income and the number of household members [69]. Almost 90% of the respondents have an income of at least 1000 € per month. In comparison with the city's high share of people with a migrant background, this group is significantly underrepresented, an issue also known from other written surveys [70]. The reasons for this include linguistic and cultural barriers discouraging participation for people in this group. With regard to travel mode availability, more than 80% of the respondents have a car; a slightly higher share have a bicycle.

3.3.2. Perceptions of the Cycle Street

To determine a respondent's individual perceptions regarding the cycle street intervention, we included 24 items in the questionnaire referring to either the implementation in Senefelderstraße or the concept of a cycle street in general. There were 15 items in the questionnaire related to statements about the implementation, requesting the perceptions of those participants who at least occasionally go there (n = 579) by means of a five-point Likert scale (Table 2). Participants who never visit Senefelderstraße (n = 122) were unable to evaluate these items and were therefore excluded from respective analyses.

Table 1. Socio-demographic attributes and travel mode access within the study sample areas.

	Senefelder Neighbourhood	Reference Neighbourhood	Total Sample	City of Offenbach
Socio-demographics				
female	53%	49%	51%	49% [63]
age (mean value)	46 years	47 years	46 years	40 years [71]
higher education entrance qualification [1]	73%	76%	74%	*no data*
employed/in education [2]	77%	77%	77%	*no data*
monthly net income (mean value) [3]	2074 €	2155 €	2113 €	*no data*
migrant background [4,***]	27%	26%	26%	63% [63]
Travel mode availability				
car availability	82%	83%	83%	*no data*
bicycle availability	86%	84%	85%	*no data*
N	365	336	701	138,853 [63]

[1] Abitur, A-Level or high school degree; [2] employed full-time, employed part-time or in education/school/college; [3] calculated as the quotient of the mean value of the stated monthly net household income range (queried using the levels: less than 1000 €; 1000 € to less than 2000 €; 2000 € to less than 3000 €; 3000 € to less than 4000 €; 4000 € to less than 5000 €; 5000 € and more) and number of household members (adjusted according to the OECD-modified scale [69]: 1 adult valued 1.0 members, further adults: 0.5, children under 14:0.3); [4] either the respondent's country of birth or his/her parent's country of birth is not Germany; *** significant difference between total sample and city of Offenbach total population (binomial test, $p < 0.001$).

Based on the fifteen items, a principal component analysis (PCA) was conducted, which resulted in four factors with an adequate eigenvalue (≥1) [72,73]. Factor 1 "high quality and positive effects" outlines widespread satisfaction with the implementation due to improvement in air quality, cycling encouragement, noise and car traffic reduction, and safety. Factor 2 "clear identifiability" involves a positive evaluation of the cycle street's identifiability due to clear markings and signs. Factor 3 "forced car traffic detours and avoidance" describes car restrictions and avoidance emerging since the implementation of the cycle street. Factor 4 "traffic conflicts and speeding" indicates perceived negative incidents comprising conflicts between cyclists and car traffic and car speeding.

With regard to the perception of the cycle street as a concept in general, a further PCA was performed with nine items, which all participants answered. Again, only factors with an acceptable eigenvalue (≥1) were implemented (Table 3). The first factor "improving cycling effectively" correlates with items related to positive judgements of the concept, as it is perceived as a good measure to encourage cycling. The second factor "hindering car traffic" outlines the aspects of the concept being obstructive to car traffic.

Table 2. Correlations of resulting factors with initial items for the principal component analysis (PCA) regarding the cycle street implementation in Senefelderstraße.

Items Regarding the Cycle Street Implementation in Senefelderstraße	Mean	SD	High Quality and Positive Effects	Clear Identi-Fiability	Factor Forced Car Traffic Detours and Avoidance	Traffic Conflicts and Speeding
"I think that noise has decreased in the street since the implementation."	1.57	1.16	0.803	0.061	0.193	−0.155
"I think that air quality has improved in the street since the implementation."	1.23	1.09	0.744	−0.046	0.160	−0.119
"I think that car traffic has decreased in the street since the implementation."	1.28	1.19	0.695	0.022	0.233	−0.216
"For me, the implementation has improved the quality of the street."	2.00	1.38	0.679	0.148	−0.436	0.083
"Overall, I am satisfied with the implementation of the cycle street."	2.02	1.30	0.637	0.311	−0.428	−0.096
"I feel safe on the cycle street."	2.12	1.23	0.584	0.286	−0.377	−0.212
"Since the implementation, I ride my bike more often within the street."	1.40	1.41	0.576	−0.018	−0.264	0.336
"Since the implementation, bicycle traffic has increased in the street."	2.06	1.17	0.457	0.198	−0.093	0.379
"The signs clearly indicate that Senefelderstraße is a cycle street."	2.52	1.28	0.070	0.843	−0.076	−0.006
"The cycle street can be identified as such."	2.92	1.14	0.050	0.842	−0.092	0.021
"The markings on the street are clear."	2.42	1.37	0.102	0.841	−0.031	−0.061
"Since the implementation, I am forced to make detours by car."	0.99	1.38	0.164	−0.010	0.786	−0.105
"Since the implementation, I try to avoid Senefelderstraße."	0.82	1.20	−0.062	−0.120	0.773	0.098
"I have a feeling that cars often exceed the speed limit of 30 km/h within the street."	2.97	1.21	−0.051	−0.010	−0.096	0.784
"I have often observed conflicts between bicycle and car traffic within the street." (Items measured on a five-point Likert scale: 0 = "I strongly disagree"—4 = "I fully agree")	1.88	1.43	−0.274	−0.107	0.240	0.741

PCA with varimax rotation; only factors with eigenvalues ≥ 1 were considered; loadings ≤ 0.4 are shown in grey; N = 579; Kaiser-Meyer-Olkin = 0.812; Bartlett's test of Sphericity: $\chi^2 = 2989.12$, df = 105, $p = 0.000$; Total variance explained: 63.7%.

Table 3. Correlations of resulting factors with initial items for the principal component analysis (PCA) regarding the cycle street as a concept.

Items Regarding the Cycle Street as a Concept	Mean	SD	Factor	
			Improving Cycling Effectively	Hindering Car Traffic
"I think it is a good idea to implement cycle streets in the city of Offenbach."	2.93	1.30	0.886	−0.258
"Cycle streets are an important measure to foster bicycle traffic."	3.01	1.13	0.876	−0.125
"I like the idea of cycle streets."	3.01	1.25	0.870	−0.251
"I am not convinced by the concept of cycle streets."	1.40	1.37	−0.801	0.334
"Cycle streets improve the safety of cyclists."	2.92	1.20	0.757	0.049
"Cycle streets are a waste of money."	1.16	1.25	−0.740	0.384
"I would cycle in cycle streets even though they were not on my direct route"	2.16	1.33	0.705	−0.157
"Above all, cycle streets result in detours having to be taken by cars."	2.10	1.19	−0.079	0.857
"Cycle streets are obstructive to car traffic." (Items measured on a five-point Likert scale: 0 = "I strongly disagree"—4 = "I fully agree")	2.18	1.21	−0.234	0.755

PCA with varimax rotation; only factors with eigenvalues ≥ 1 were considered; loadings ≤ 0.4 are shown in grey; N = 701; Kaiser-Meyer-Olkin = 0.918; Bartlett's test of Sphericity: χ^2 = 4166.47, df = 36, *p* = 0.000; Total variance explained: 70.7%.

3.3.3. Stage Models of Behavioral Change

To evaluate the intervention's effects on travel behavior change, we applied the approach of the SSBC model (Section 2) considering behavior change as an individual process of transitions between certain stages. As the cycle street intervention addresses both bicycle and car use behavior, two stage models were developed: the stage model for frequent bicycle use and the stage model for reduced car use. Indicators related to the adoption of a new behavior specify the former model. The latter model involves indicators concerning the abandonment of the previous behavior. Compared to a combined model, the separation into two models provides more precise conclusions about each of the travel modes addressed. Stage models related to car reduction only or bicycle use only can also be found within previous studies [44,47,57,61,62].

Just like the SSBC, we discerned four stages of behavior change within the two models: (1) "predecision", (2) "preaction", (3) "action", and (4) "postaction". Based on previous studies, we developed several indicators to measure individual transitions of "goal intention", "behavioral intention", and "implementation intention". If certain indicators could be established, the transition from one stage to another occurred. Thus, the respective person could be assigned to the following stage. The questionnaire's items used to evaluate individual indicators included actual use, intentions, and attitudes related to cycling and car use and are described in the following sections.

Stage Model of Frequent Bicycle Use

The first model refers to the process of cycling (Figure 4). As the implementation of frequent bicycle use constitutes the final stage of this process, all participants who already frequently use their bike in everyday life (at least once a week) were assigned to the stage of postaction (stage 4; [46,62]). Thus, we started the assignments in terms of the last stage. Within this stage, the implementation intention was put into practice. Participants who did not belong to this group but stated the explicit plan of using a bicycle more frequently were assigned to the stage of action (stage 3; [46]). The presence of an explicit plan indicates a firm behavioral intention without having implemented a new behavior yet. Those of the remaining respondents who showed positive attitudes as well as perceived behavioral control concerning bicycle use were classified into the stage of preaction (stage 2; [45]). Respondents assigned to this stage are prepared and open to use a bicycle more often (goal intention) without planning it explicitly. Participants in the stage of predecision (stage 1) meet none of the previous conditions, indicating no intention to use a bicycle frequently.
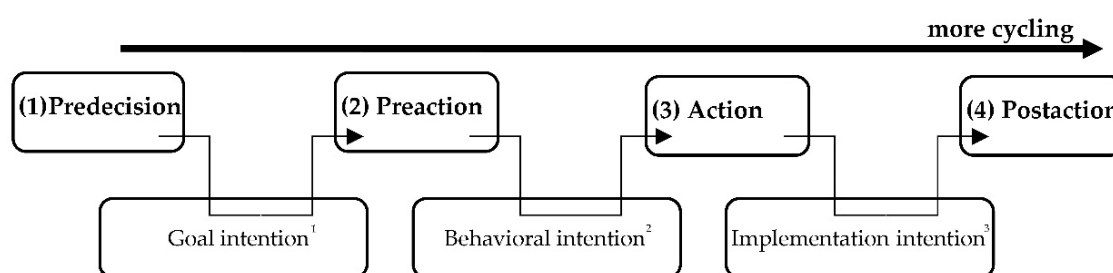
[1] goal intention indicated by perceived behavioral control over cycling ("fully agree" or "somewhat agree" to the statement "I am able to reach all relevant everyday destinations by bicycle." or neither "fully agree" nor "somewhat agree" to both statements "When riding a bicycle I feel unsafe." and "For me riding a bike is exhausting and uncomfortable.") and positive attitude towards cycling ("fully agree" or "somewhat agree" to at least one of the statements "The bicycle is the ideal means of transport for me.", "Riding my bike is fun for me.", "When riding a bicycle, I am flexible and free.")
[2] behavioral intention indicated by the explicit plan to increase cycling ("fully agree" or "somewhat agree" to the statement "I have planned to ride my bicycle more often in everyday life.")
[3] implementation intention indicated by frequent use of the bicycle ("1-3 days per week" or "(almost) every day" in summer or winter)

Figure 4. Stages and transition indicators of the SSBC model of frequent bicycle use (own illustration).

Table 4 shows the resulting affiliations of the participants to the stages of the frequent bicycle use model. Most of the participants are assigned to the postaction stage indicating that they frequently

use a bicycle. 26% belong to the stage of predecision. The middle stages of preaction and action have lower shares. Within the Senefelder neighborhood, significantly more respondents are assigned to the postaction stage, while fewer participants are within the stage of predecision.

Table 4. SSBC stages for frequent bicycle use within the study sample areas.

	Senefelder Neighborhood	Reference Neighborhood	Total Sample
Stage of behavioral change (U = 56,699) **			
predecision	22%	30%	26%
preaction	9%	6%	8%
action	6%	8%	7%
postaction	63%	56%	59%
N	365	336	701

** significant difference between the study sample areas (Mann-Whitney-U, $p < 0.05$).

Stage Model of Reduced Car Use

The stage model of reduced car use describes the tendency to give up using a car (Figure 5). Again, the stage allocation commenced at the final stage of postaction (stage 4) involving respondents who already showed the questioned behavior of a low frequency of car use in everyday life—less than once a week—and thus put the implementation intention into practice. Participants who still frequently use a car but stated the explicit plan to reduce their use (behavioral intention) were assigned to the stage of action (stage 3; [41,45]). Those of the remaining respondents who show personal norms and perceived behavioral control for car use reduction were assigned to the stage of preaction (stage 2; [39]). They are prepared and feel obliged to reduce their car use—thus indicating the goal intention of questioning previous behavior—without planning it explicitly. The remaining participants were assigned to the stage of predecision (stage 1), still using their car frequently and neither indicating preparedness nor plans to reduce their car use.
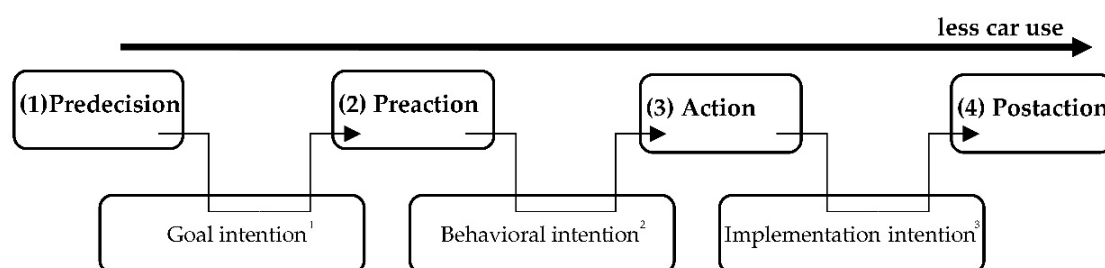
[1] goal intention indicated by perceived behavioral control over reduced car use ("fully agree" or "somewhat agree" to at least one of the statements "I can do my everyday life without a car." or "For me it would be no problem to use the car less frequently.") and personal norms of reduced car use ("fully agree" or "somewhat agree" to at least one of the statements "Car traffic is a huge problem for environmental protection." or "Most of the people important to me would be glad if I use the car less frequently.")
[2] behavioral intention indicated by the explicit plan to reduce car use ("fully agree" or "somewhat agree" to the statement "It is my firm goal to use the car less frequently and I know exactly how to achieve this goal.")
[3] implementation intention indicated by reduced car use ("(almost) never" or "less than once a month" or "1-3 days per month" as driver and passenger)

Figure 5. Stages and transition indicators of the SSBC model of reduced car use (own illustration).

Similar to the model of frequent bicycle use, the stage assignments of reduced car use reveal a majority of respondents within the stage of postaction, albeit to a lesser extent (Table 5). About one third of the participants belongs to the stage of predecision, indicating frequent car use without showing willingness to change this behavior. The middle stages of preaction and action add up to 26%. The results reveal no significant differences between the two study sample areas.

Table 5. SSBC stages for reduced car use within the study sample areas.

	Senefelder Neighborhood	Reference Neighborhood	Total Sample
Stage of behavioral change (U = 58,428)			
predecision	31%	34%	33%
preaction	15%	16%	16%
action	10%	10%	10%
postaction	43%	39%	41%
N	365	336	701

No significant difference between the study sample areas (Mann-Whitney-U, $p < 0.10$).

4. Evaluation of the Cycle Street Intervention in Offenbach—Results of the Case Study

In accordance with the approach of MaxSUMO, our evaluation of the impact of the cycle street involves the following steps: an analysis of indicators concerning awareness, use, and perceptions of the cycle street (Section 4.1), a discussion of the use of and the attitudes towards the mobility options of cycling and car use reduction (Section 4.2), and the application of two models of behavioral change (Section 4.3) comprising an analysis of related determinants by means of multivariate regressions (Section 4.4).

4.1. Evaluation of Awareness, Use, and Perceptions of the Intervention

To evaluate the implementation of the cycle street in Offenbach am Main, we examined aspects of awareness, use, and perception (Table 6). The results show that, within the Senefelder neighborhood, awareness (93%) and regular use (89%)—regardless of the means of transport used—of the cycle street are significantly higher than in the reference neighborhood.

Table 6. Cycle street awareness, use, and perceptions within the study sample areas.

	Senefelder Neighborhood	Reference Neighborhood	Total Sample
Cycle street awareness and use (n = 701) [1]			
awareness [4] ($\chi^2 = 141.455$) ***	93%	54%	74%
regular use (all modes) [5] ($\chi^2 = 307.058$) ***	89%	23%	57%
Perception of the implementation in Senefelderstraße (n = 579) [2,3]			
high quality and positive effects (t = −5.315) ***	−0.17	0.27	0.0
clear identifiability (t = 1.250)	0.04	−0.07	0.0
forced car traffic detours and avoidance (t = −3.877) ***	−0.13	0.20	0.0
traffic conflicts and speeding (t = 8.471) ***	0.26	−0.42	0.0
Perception of the cycle street as a concept (n = 701) [2]			
improving cycling effectively (t = −3.846) ***	−0.14	0.15	0.0
hindering car traffic (t = −1.341)	−0.05	0.05	0.0

[1] significant difference between the study sample areas (Pearson's chi-square, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$); [2] significant difference between the study sample areas (*t*-test, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$); [3] limited to respondents using Senefelderstraße at least occasionally (n = 579); [4] awareness of the cycle street: answer of "yes" to "Have you already heard about the cycle street in Senefelderstraße?"; [5] regular use of the cycle street: answer of "frequently" to "How often do you use Senefelderstraße by car/by bicycle/on foot?".

With regard to the factors of the perception of the implementation in Senefelderstraße and the cycle street concept in general, a higher level of satisfaction related to quality and positive effects as well as improvement for cycling can surprisingly found among respondents living in the reference neighborhood. However, participants in the reference neighborhood are significantly more likely to avoid Senefelderstraße, while those living in the Senefelder neighborhood perceive emerging traffic conflicts and speeding more often. The factors of identifiability and hindering car traffic indicate no differences between the investigation areas.

4.2. Evaluation of Bike and Car Use and Attitudes

In order to evaluate the possible effects of the cycle street implementation on individual mobility, survey items referring to cycling and car use travel behavior and attitudes were taken into account (Table 7). The results show that frequent bicycle use is significantly more common within the Senefelder neighborhood where the cycle street intervention is taking place. 62% of the respondents in the Senefelder neighborhood stated to ride a bike frequently in summer; in winter still a share of 35%. With a proportion of 48%, frequent car use is less common than frequent bicycle use in summer in the Senefelder neighborhood.

Table 7. Bicycle and car-related behavior and attitudes within the study sample areas.

	Senefelder Neighborhood	Reference Neighborhood	Total Sample
Bicycle and car use (n = 701) [1]			
frequent bicycle use in summer (χ^2 = 3.376) *	62%	55%	59%
frequent bicycle use in winter (χ^2 = 4.801) **	35%	27%	31%
frequent car use as driver (χ^2 = 2.456)	48%	54%	51%
frequent car use as passenger (χ^2 = 1.919)	23%	19%	21%
(Frequent use: "1–3 days per week" or "(almost) daily")			
Bicycle and car attitudes (n = 701) [2]			
"Riding my bike is fun for me." (t = 0.495)	2.9	2.8	2.8
"When riding a bicycle, I am flexible and free." (t = 0.685)	2.6	2.5	2.5
"The bicycle is the ideal means of transport for me." (t = 1.518)	2.2	2.1	2.1
"When riding a bicycle I feel unsafe." (t = −1.913) *	1.6	1.8	1.7
"For me riding a bike is exhausting and uncomfortable." (t = −0.492)	1.1	1.2	1.2
"Car traffic is a huge problem for environmental protection." (t = 0.668)	3.2	3.1	3.2
"When sitting in a car, I feel safe and protected." (t = 0.279)	2.3	2.3	2.3
"For me the car is the best way to travel." (t = 0.631)	1.9	1.9	1.9
"Travelling by car is fun and a passion of mine." (t = 0.007)	1.4	1.4	1.4
(Items measured on a five-point Likert scale: 0 = "I strongly disagree"—4 = "I fully agree")			
N	365	336	701

[1] significant difference between the study sample areas (Pearson's chi-square, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$);
[2] significant difference between the study sample areas (*t*-test, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$).

With regard to bicycle attitudes, there are high approval rates relating to fun, flexibility, and freedom of riding in both neighborhoods. The feeling of a lack of safety associated with cycling is, however, significantly higher in the reference neighborhood.

In both neighborhoods, respondents show a high level of awareness of the environmental issues of car traffic and little agreement with car travel relating to fun and passion. Overall, the attitudes towards car use show no differences between the neighborhoods.

4.3. Evaluation of Behavioral Change

As described in Section 3.3.3, we applied two stage models to evaluate the processes of travel behavior change. To determine the significance of the cycle street intervention for the position within this stage model, we analyzed possible correlations between the intervention factors discussed in Section 4.1 and the stage affiliation by means of Pearson's chi-square test and Spearman's rank

correlation coefficient [74]. Due to the relatively small number of cases assigned to the middle stages, these were combined into one single stage ("preaction/action") indicating a status of transition between the stages of habitual behavior.

The analyses reveal that proximity, awareness, use, and positive evaluations of the cycle street have positive correlations with the progress within the process of frequent bicycle use (Table 8). A higher share of respondents within the postaction stage lives in the Senefelder neighborhood. In addition, the proportion of awareness and the regular use regarding the cycle street are much higher within stages 2–3 and 4 compared to the predecision stage. Furthermore, perceptions of the cycle street's high quality and positive effects as well as of the concept of improving cycling effectively are more positive within the phases of preaction/action and postaction. Remarkably, within stages 2–3, the identifiability of the cycle street is evaluated better than within the other stages. Avoidance of Senefelderstraße and the perception of cycle streets as being a hindrance to car traffic are significantly higher within stage 1 than in the other stages.

Table 8. Cycle street proximity, awareness, use, and perceptions by SSBC stage for frequent bicycle use.

	Stage 1 Predecision	Stage 2–3 Preaction/Action	Stage 4 Postaction
Cycle street proximity, awareness and use (n = 701) [1]			
proximity [4] (χ^2 = 5.276) *	48%	54%	55%
awareness [5] (χ^2 = 29.992) ***	62%	66%	82%
regular use (all modes) [6] (χ^2 = 33.936) ***	41%	50%	66%
Perception of the implementation in Senefelderstraße (n = 579) [2,3]			
high quality and positive effects (ρ = 0.246) ***	−0.46	−0.06	0.17
clear identifiability (ρ = −0.050)	−0.05	0.26	−0.04
forced car traffic detours and avoidance (ρ = −0.259) ***	0.40	0.15	−0.17
traffic conflicts and speeding (ρ = 0.088) *	−0.16	−0.09	0.08
Perception of the cycle street as a concept (n = 701) [2]			
improving cycling effectively (ρ = 0.273) ***	−0.48	0.06	0.19
hindering car traffic (ρ = −0.205) ***	0.32	0.09	−0.16
N	179	106	416

[1] significant difference between the stages (Pearson's chi-square, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$); [2] significant difference between the stages (Spearman-Rho, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$); [3] limited to respondents using Senefelderstraße at least occasionally (n = 579); [4] proximity: living in the Senefelder neighborhood "yes"; [5] awareness of the cycle street: answer of "yes" to "Have you already heard about the cycle street in Senefelderstraße?"; [6] regular use of the cycle street: answer of "frequently" to "How often do you use Senefelderstraße by car/by bicycle/on foot?".

For the analyses of reduced car use, we also examined potential correlations with the factors of the cycle street intervention. As Table 9 shows, being regularly within Senefelderstraße differs considerably and reveals a high value within the middle stages. Furthermore, a lower perception of high quality and positive effects of the cycle street as well as traffic conflicts and speeding is in the stage of predecision. Similarly, the values for forced car traffic detours and avoidance as well as for hindering car traffic are the highest within the stage of predecision and thus among respondents who show no willingness to reduce their car use.

Table 9. Cycle street proximity, awareness, use, and perceptions by SSBC stage for reduced car use.

	Stage 1 Predecision	Stage 2–3 Preaction/Action	Stage 4 Postaction
Cycle street proximity, awareness and use (n = 701) [1]			
proximity [4] ($\chi^2 = 1.379$)	50%	51%	55%
awareness [5] ($\chi^2 = 0.002$)	74%	74%	74%
regular use (all modes) [6] ($\chi^2 = 6.390$) **	52%	64%	57%
Perception of the implementation in Senefelderstraße (n = 579) [2,3]			
high quality and positive effects ($\rho = 0.201$) ***	−0.39	0.28	0.12
clear identifiability ($\rho = -0.038$)	0.02	0.03	−0.03
forced car traffic detours and avoidance ($\rho = -0.209$) ***	0.29	−0.07	−0.18
traffic conflicts and speeding ($\rho = 0.167$) *	−0.20	−0.08	0.21
Perception of the cycle street as a concept (n = 701) [2]			
improving cycling effectively ($\rho = 0.260$) ***	−0.41	0.16	0.22
hindering car traffic ($\rho = -0.120$) ***	0.16	−0.01	−0.13
N	229	183	289

[1] significant difference between the stages (Pearson's chi-square, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$); [2] significant difference between the stages (Spearman-Rho, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$); [3] limited to respondents using Senefelderstraße at least occasionally (n = 579); [4] proximity: living in the Senefelder neighborhood "yes"; [5] awareness of the cycle street: answer of "yes" to "Have you already heard about the cycle street in Senefelderstraße?"; [6] regular use of the cycle street: answer of "frequently" to "How often do you use Senefelderstraße by car/by bicycle/on foot?".

4.4. Regression Analyses of Factors Influencing Behavioral Change

To determine whether the factors of the cycle street intervention actually have an influence on bicycle and car use behavior, as the results of the previous sections suggest, we conducted binary logistic regressions for each of the stages within the two stage models. Binary logistic regression is a multivariate statistical method for analyzing correlations between various independent variables and a dependent variable with only two possible values. The influence of the independent variables on the probability of the dependent variable having the value of 1 is calculated. Besides the variables referring to the intervention, control variables concerning travel mode access and socio-demographics were added to the regression analyses as independent variables (Table 10). The binary dependent variables used indicate the respective stage affiliation (1 = assigned to this stage; 0 = not assigned to this stage) of frequent bicycle use or reduced car use resulting in six regression models.

Due to the inclusion of the factors related to the perceptions of the concrete implementation not assessed by all participants, the regression models are based on just 579 cases. All of the calculated regressions—except of the model for stages 2–3 of frequent bicycle use—reveal an acceptable coefficient of determination based on Nagelkerke's R^2 measure [75]. The regressions of stage 1 and stage 4 within the bicycle stage model provide a high goodness of fit in particular. The influence of the independent variables is indicated by the odds ratios [Exp(β)] expressing the change in probability of stage affiliation in the case of an increase in the variable's value.

Table 10. Binary logistic regression models for SSBC stages of frequent bicycle use and reduced car use.

	Model of Frequent Bicycle Use			Model of Reduced Car Use		
	Stage 1 Exp(β)	Stage 2–3 Exp(β)	Stage 4 Exp(β)	Stage 1 Exp(β)	Stage 2–3 Exp(β)	Stage 4 Exp(β)
Cycle street proximity, awareness and use						
proximity (1 = yes; 0 = no)	0.673	2.817 ***	0.609	1.539	0.578 *	1.183
awareness (1 = yes; 0 = no)	0.537	0.699	2.036 **	1.040	1.041	0.879
regular use (all modes) (1 = yes; 0 = no)	0.507 *	0.497 **	2.350 ***	0.494 **	2.483 ***	0.763
Perception of the implementation in Senefelderstraße						
high quality and positive effects	0.606 ***	0.791	1.511 ***	0.583 ***	1.581 ***	1.008
clear identifiability	0.887	1.393 **	0.859	1.118	0.976	0.910
forced car traffic detours and avoidance	1.125	1.359 **	0.754 **	1.399 **	0.899	0.796 *
traffic conflicts and speeding	0.980	0.846	1.126	0.717 ***	0.925	1.504 ***
Perception of the cycle street as a concept						
improving cycling effectively	0.554 ***	1.328 *	1.278 *	0.723 **	1.092	1.359 **
hindering car traffic	1.616 ***	1.039	0.722 ***	1.050	0.988	0.932
Travel mode availability						
bicycle availability (1 = yes; 0 = no)	0.019 ***	2.210 *	46.149 ***	1.596	0.562 *	1.099
car availability (1 = yes; 0 = no)	1.525	0.823	0.925	34.442 ***	11.765 ***	0.032 ***
Socio-demographics						
female (1 = yes; 0 = no)	1.433	1.117	0.776	0.727	1.186	1.148
age	0.988	0.993	1.014	1.001	1.009	0.991
higher education entrance qualification (1 = yes; 0 = no)	0.514 **	1.052	1.459	1.118	0.734	1.261
employed/in education (1 = yes; 0 = no)	0.441 **	0.872	1.952 **	0.525 **	1.752 *	1.149
monthly net income	1.354 **	0.943	0.854	1.237 **	1.240 **	0.660 ***
migrant background (1 = yes; 0 = no)	1.064	1.272	0.819	0.837	1.808 **	0.646 *
Constant	27.792	0.142	0.011	0.013	0.012	42.364
−2 Log-Likelihood	363.713	442.410	539.951	557.525	585.534	585.367
R^2 Nagelkerke	0.537	0.080	0.430	0.352	0.208	0.392
Omnibus Test	0.000	0.069	0.000	0.000	0.000	0.000
N	579	579	579	579	579	579

Each column represents one logistic regression model with the dependent variable of stage assignment (1 = assigned to this stage, 0 = not assigned to this stage); odds ratio values' (Exp(β)) significance: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; limited to respondents using Senefelderstraße at least occasionally (n = 579).

The results show that the availability of the respective travel mode—bicycle or car—influences the related stage affiliation. More specifically, the availability of a bike positively affects belonging to stages 2–3 and 4 of the frequent cycling model, while no access to a bicycle increases the probability of being in stage 1. Having a car at one's disposal positively affects stage 1 and stages 2–3 affiliation within the reduced car model, whereas no availability favors belonging to stage 4.

Aside from transport mode availability, several intervention variables show a distinct impact on behavioral change processes, in particular using Senefelderstraße regularly as well as the evaluation of the intervention's quality. Accordingly, the implementation of frequent bicycle use is positively affected by regular use of the cycle street (irrespective of means of transport), awareness of the cycle street, and perception of high quality and positive effects of the intervention. Furthermore, using the cycle street regularly and identifying its positive characteristics encourage affiliation to the stage of preaction/action for car use reduction and counteract the stage of predecision.

While perceived traffic conflicts and speeding within Senefelderstraße has no significant effect on one of the bicycle use stages, this factor is associated with the reduced car model, indicating that being one of those respondents who does not use a car frequently is related to experiencing traffic issues. The perceptions of the cycle street concept primarily affect stages 1 and 4 within both behavioral change models. Not being convinced of the concept's benefits is positively associated with the stages of predecision, whereas positivity towards the concept encourages affiliation to both stages of postaction.

The socio-demographic variables also contribute to the regression models to some extent. Respondents who do not have a higher education or are not in employment or in education are more likely to be in stage 1 of the bicycle use model and show no willingness towards frequent cycling. Participants in employment or education, which indicates frequent activities and a higher need for traveling, are positively associated with frequent bicycle use. In contrast, data suggest that the higher the income is, the higher is the probability of maintaining frequent car use. This relation can be explained by the costs of affording one's own car. Previous studies suggest that limited financial resources in particular inhibit access to a car [67].

5. Discussion

As the results of the survey on the cycle street show, the intervention variables examined point out differences between the two study sample areas and are linked to individual perceptions and travel behavior, indicating an actual impact of the cycle street. The study provides new findings in particular on the residents' evaluations of such an intervention, its effects on travel behavior, as well as on methodological challenges in assessing interventions. These are discussed in the following section.

5.1. Residents' Evaluations of the Cycle Street Intervention

First of all, a majority of the residents were aware of the cycle street implementation. The higher share of awareness and the regular use within the Senefelder neighborhood are not surprising since these respondents live closer to Senefelderstraße and therefore actually encounter the street. Participants of the reference neighborhood are more likely to avoid Senefelderstraße since the cycle street was implemented. This can be explained by the fact that, as non-residents of the Senefelder neighborhood, they are not allowed to pass through the street by car any more.

Surprisingly, the perceptions of the cycle street's quality and concept indicate a lower level of acceptance by those people living close to the intervention. This result can be attributed to the coincidently higher affirmation of perceived traffic conflicts, which are primarily noticed by those living directly nearby. In particular, many respondents noticed car speeding. Traffic monitoring performed after the cycle street's implementation confirmed this impression in terms of frequent increased velocities of more than 20 km/h [76]. Only a few previous studies revealed such car speeding problems within cycle streets [28,30]. Additionally, past research points out that the number of accidents or traffic conflicts within cycle streets is similar or even lower compared to common streets [28,34,77]. Since no respective data are available for Senefelderstraße, uncertainty persists as to whether the

negative perceptions of the residents are justified or not. Relevant papers suggest that car speeding and accidents within cycle streets depend on the existing regulations and design [28,30,77]. Hence, related improvements might contribute to a higher level of safety and quality within the street and thus to a higher satisfaction with the implementation.

5.2. Impact of the Cycle Street Intervention on Travel Behavior

Regardless of the traffic issues mentioned, the analyses indicate a positive effect of the cycle street implementation on bicycle use and willingness to cycle. Thus, the results support previous research assumptions of cycle streets encouraging cycling [14,36]. In contrast to traffic monitoring primarily conducted in previous studies, the survey provides evidence that the intervention and its perceived characteristics influence individual intentions and contribute to the process of behavioral change. The allocation to the stages points to a significantly lower share of respondents living close to the intervention that are assigned to the stage 1 of predecision (Table 4). In addition, the results show a higher proportion within the Senefelder neighborhood of those respondents using a bicycle at least once a week, while the feeling of being unsafe when riding a bike is slightly higher within the reference neighborhood (Table 7).

It turns out that, in particular, the awareness and the regular use of the cycle street intervention—factors that are more distinct within the Senefelder neighborhood—are linked to the transition into the stage of postaction and thus might positively affect the ability to maintain regular bicycle use. Bamberg et al. (2011) suggest that, to support this transition to a habitual implementation, new services and infrastructures represent an effective type of intervention [57]. Our evaluations confirm this assumption, as the cycle street in particular is relevant for the implementation of cycling frequently. Furthermore, the factors of satisfaction concerning the perceived high quality of the implementation and the cycle street concept contribute to frequent bicycle use and counteract an affiliation to the first stage of bicycle use. Thus, an improvement in the quality of the intervention might encourage the probability of cycling even more.

With regard to car use, the cycle street does not result in maintained behavior changes, as no significant differences in frequency of use can be found between the examined neighborhoods (Table 7). This result supports the findings of the few previous studies related to car use changes after the implementation of a cycle street based on traffic counts [28,30]. However, the intervention seems to raise openness and willingness for car use reduction. In particular, the perceived high quality of the intervention and being within Senefelderstraße regularly is linked to the transition from the stage of predecision to the middle stages of preaction and action. By its implementation, the cycle street draws attention to the transport mode of cycling and thus to an alternative mobility option, questioning the previous focus on car use [40]. Yet, the implementation of infrequent car use (stage 4) is strongly associated with perceived conflicts in Senefelderstraße. As respondents assigned to this stage include a high share of pedestrians and cyclists, traffic issues related to cars, such as speeding, appear more present within this group. Related improvements within the cycle street might facilitate non-motorized traffic. However, the results indicate that the impact of the intervention on actual car use is lower than on bicycle use. Accordingly, cycling more frequently is not necessarily resulting in using the car less frequently.

5.3. Methodology

Overall, the application of the stage-based SSBC model provided the advantage of considering not only the actual individual behavior but also preceding perceptions and intentions, which have shown to be influenced by the intervention as well. Previous studies using the SSBC for evaluating the impact of other intervention types also show that the transition to all of the stages might be affected [45,48,78]. Furthermore, the separation of the SSBC into two models—one for cycling and one for car use—turned out to be useful, as the results indicate differences related to these modes of transport addressed by the intervention. Thus, on the basis of the adopted approach, precise conclusions could be drawn regarding

the cycle street's actual impact on the processes of travel behavior change. However, a process of change cannot explain behavior in all cases. For instance, car use might have always been infrequent due to the lack of a driving license, and thus no transition was made to another stage. It is therefore not clear whether certain intentions or attitudes have to precede the actual behavior. The comparatively small number of cases assigned to the middle stages of preaction and action was to be expected, as these stages represent a status of transition between habitual behaviors and usually only persist for a certain period [45]. Previous studies show similar shares of these stage affiliations [41,45,48]. As the respective regression models reveal a low goodness of fit, the results referring to the middle stages should be considered cautiously. With a higher number of respondents and thus a higher number of individuals assigned to these stages, this issue could be addressed within further research.

Additionally, further items, for example, those related to perceived behavioral control or the plans for behavioral change, might improve the assignment to the stages. However, as measured mode use, intentions, and perceptions are based on self-reported, subjective statements, biases related to actual behavior might always occur [44]. Moreover, further control variables could enhance the results of the regression models concerning the actual effects of the cycle street variables. Previous research indicates that, besides the availability of a bicycle and socio-demographic attributes, cycling is dependent on a variety of factors, comprising the distances to be covered, the quality of the bicycle equipment, and the social environment [79,80].

6. Conclusions

In order to face challenges related to motorized traffic, the promotion of bicycle use can be found within many urban areas around the world. By the implementation of cycle streets, an increasing number of cities aims to facilitate cycling while discouraging car use at the same time. Previous research on the impact of cycle streets is limited to a small number of studies indicating an increase in bicycle traffic within the respective streets [25,26]. However, as these studies are primarily based on traffic volume monitoring, uncertainty persists about the actual effects of the intervention and its characteristics on the individual willingness to adopt sustainable travel behavior. Therefore, the objective of this paper was to evaluate whether cycle street interventions actually trigger travel behavior changes related to cycling and car use.

For this purpose, we conducted a written household survey in the city of Offenbach am Main involving residents directly affected by a cycle street implementation and residents of a reference neighborhood. The data used included perceptions of the cycle street as well as individual intentions and attitudes related to cycling and car use. In order to evaluate impacts on individual behavior, we applied two self-regulated stage models (SSBC) specifying the individual's stage within the processes of behavioral change: one related to frequent bicycle use and the other to reduced car use.

The analyses indicate a positive impact of the cycle street implementation on both processes of adapting sustainable travel behavior, albeit in a different way. Foremost, the encounter with the cycle street seems to encourage the implementation of frequent cycling behavior in everyday life. Although no such effect on actual car use could be observed, the results show the intervention's positive effect on openness and willingness to reduce car use. The individual perceptions of the cycle street's characteristics are linked to the affiliations within both stage models. In particular, a positive evaluation of the implementation's quality counteract low willingness of cycling and reducing car use. However, the participants' perceptions also show that conflicts between cars and cyclists as well as car speeding pose a major problem, causing dissatisfaction with the cycle street.

Therefore, despite the positive impact of the cycle street intervention on bicycle use, the findings reveal the need for further research related to the design of the implementation, other types of interventions, and the evaluation of individual travel behavior. As the results indicate, the identification of design measures addressing the perceived traffic issues might result in an enhancement of the positive effects of the intervention. In particular, an improvement in the cycle street's safety would meet the needs of inexperienced cyclists [81]. Initial corresponding examples include speed management

design elements, such as narrowing by means of curb extensions, and refuge islands [20,77]. As the results show no impact on actual car use frequency, additional interventions as useful supplements of the cycle street should be implemented and evaluated. Previous studies claim that car use reduction can only be triggered effectively by extensive car deterrent strategies, such as parking or congestion pricing [10]. Furthermore, the implementation of an entire network of cycle streets or other bicycle infrastructures, such as separated bike lanes [82] and bike-sharing systems [83], might reveal a stronger influence on individual cycling behavior. Moreover, further research regarding the evaluation methods of individual behavior and behavioral changes could provide additional insights into the promotion of sustainable travel. Although the suitability of the SSBC was analyzed within several previous studies [39,41,44], additional studies verifying existing constructs or new variables could contribute to the model's improvement.

References

1. Bernardo, C.; Bhat, C. Non-motorized Travel as a Sustainable Travel Option. In *Handbook of Sustainable Travel*; Gärling, T., Ed.; Springer: Dordrecht, The Netherlands, 2014; pp. 277–291, ISBN 978-94-007-7033-1.
2. Banister, D. *Unsustainable Transport*; Taylor & Francis: London, UK, 2005; ISBN 0-203-00388-8.
3. Gössling, S. Urban transport transitions: Copenhagen, City of Cyclists. *J. Transp. Geogr.* **2013**, *33*, 196–206. [CrossRef]
4. Popan, C. *Bicycle Utopias. Imagining Fast and Slow Cycling Futures*; Routledge: London, UK; New York, NY, USA, 2019; ISBN 978-1-138-38918-2.
5. van Wee, B. The Unsustainability of Car Use. In *Handbook of Sustainable Travel*; Gärling, T., Ed.; Springer: Dordrecht, The Netherlands, 2014; pp. 69–83, ISBN 978-94-007-7033-1.
6. Ogilvie, D.; Egan, M.; Hamilton, V.; Petticrew, M. Promoting walking and cycling as an alternative to using cars: Systematic review. *BMJ* **2004**, *329*, 763. [CrossRef] [PubMed]
7. Lanzendorf, M.; Busch-Geertsema, A. The cycling boom in large German cities—Empirical evidence for successful cycling campaigns. *Transp. Policy* **2014**, *36*, 26–33. [CrossRef]
8. Pucher, J.; Buehler, R.; Seinen, M. Bicycling renaissance in North America? An update and re-appraisal of cycling trends and policies. *Transp. Res. Part A Policy Pract.* **2011**, *45*, 451–475. [CrossRef]
9. Koska, T.; Rudolph, F. *The Role of Walking and Cycling in Reducing Congestion: A Portfolio of Measures*; FLOW: Brussels, Belgium, 2016. Available online: http://www.h2020-flow.eu (accessed on 4 December 2019).
10. Piatkowski, D.P.; Marshall, W.E.; Krizek, K.J. Carrots versus Sticks: Assessing Intervention Effectiveness and Implementation Challenges for Active Transport. *J. Plan. Educ. Res.* **2019**, *39*, 50–64. [CrossRef]
11. Pucher, J.; Dill, J.; Handy, S. Infrastructure, programs, and policies to increase bicycling: An international review. *Prev. Med.* **2010**, *50*, S106–S125. [CrossRef]
12. Pucher, J.; Buehler, R. Cycling for Everyone. *Transp. Res. Rec. J. Transp. Res. Board* **2008**, *2074*, 58–65. [CrossRef]
13. Parkin, J. *Designing for Cycle Traffic. International Principles and Practice*; ICE Publishing: London, UK, 2018; ISBN 9780727763495.

14. Eder, S. *Radverkehrsförderung mit dem Instrument der Fahrradstraße in Österreich*; KFV (Kuratorium für Verkehrssicherheit)-Diplomarbeitsreihe: Wien, Austria, 2017.

15. Saelens, B.E.; Sallis, J.F.; Frank, L.D. Environmental correlates of walking and cycling: Findings from the transportation, urban design, and planning literatures. *Ann. Behav. Med.* **2003**, *25*, 80–91. [CrossRef]

16. Litman, T.; Blair, R.; Demopoulos, B.; Eddy, N.; Fritzel, A.; Laidlaw, D.; Maddox, H.; Forster, K. *Pedestrian and Bicycle Planning. A Guide to Best Practice*; Victoria Transport Policy Institute: Victoria, BC, Canada, 2002. Available online: http://www.vtpi.org/nmtguide.doc (accessed on 27 November 2019).

17. Turoń, K.; Czech, P.; Juzek, M. The concept of a walkable city as an alternative form of urban mobility. *Sci. J. Sil. Univ. Technol. Ser. Transp.* **2017**, *95*, 223–230. [CrossRef]

18. Graf, T. (Ed.) *Einrichtung von Fahrradstraßen*, 1st ed.; Thiemo Graf Verlag: Röthenbach an der Pegnitz, Germany, 2018; ISBN 3-940217-21-2.

19. Walker, L.; Tresidder, M.; Birk, M. Fundamentals of Bicycle Boulevard Planning & Design. In *Initiative for Bicycle and Pedestrian Innovation: Center for Transportation Studies*; Portland State University: Portland, OR, USA, 2009.

20. National Association of City Transportation Officials. *Urban Bikeway Design Guide*, 2nd ed.; Island Press: Washington, DC, USA, 2014; ISBN 978-1-61091-436-9.

21. Verordnung zur Neufassung der Straßenverkehrs-Ordnung (StVO) vom 06. März 2013. *Bundesgesetzblatt Jahrgang 2013 Teil I Nr. 12*, 2013.

22. Ferguson, E. Transportation Demand Management Planning, Development, and Implementation. *J. Am. Plan. Assoc.* **1990**, *56*, 442–456. [CrossRef]

23. Litman, T. *Planning Principles and Practices*; Victoria Transport Policy Institute: Victoria, BC, Canada, 2013.

24. Reutter, U.; Kemming, H. Mobilitätsmanagement—Eine historische, verkehrspolitische und planungswissenschaftliche Einordnung. In *Mobilitätsmanagement: Wissenschaftliche Grundlagen und Wirkungen in der Praxis*, 1st ed.; Stiewe, M., Reutter, U., Eds.; Klartext: Essen, Germany, 2012; pp. 16–29, ISBN 978-3-8375-0474-3.

25. Mead, J.; McGrane, A.; Zegeer, C.; Thomas, L. *Evaluation of Bicycle-Related Roadway Measures: A Summary of Available Research*; Federal Highway Administration: Washington, DC, USA, 2014.

26. Denvall, H.; Johansson, S. Bicycle Priority Street—The Missing Link in the Safe and Sustainable Infrastructure. Master's Thesis, Master of Science Thesis in the Master's Program Infrastructure and Environmental Engineering Chalmers University of Technology, Gothenburg, Sweden, 2013.

27. Mobiel 21. First Bicycle Street Established in Ghent (Belgium). Available online: https://www.eltis.org/discover/case-studies/first-bicycle-street-established-ghent-belgium (accessed on 17 November 2019).

28. Alrutz, D.; Gündel, D.; Busek, S.; Vullriede, N.; Brünink, N.; Hagemeister, D. *Landeshauptstadt München Evaluierung Fahrradstraßen Schlussbericht*; PGV: Hannover, Germany, 2016.

29. Richard, J.; Richter-Richard, H.; Kuntz, N.; Schröder, I. *Begleituntersuchung Fahrradstraße Schillerstraße Stadt Münster*; Beiträge zur Stadtforschung, Stadtentwicklung, Stadtplanung: Aachen, Germany, 1993.

30. Manser, S.; Neumann, A.; Bubenhofer, J.; Starkermann, M. *Pilotversuch Velostrassen. Auswertung Pilotversuch*; Metron: Bern, Switzerland, 2018.

31. Khut, R. Bicycle Boulevards: Statistical Analysis of the Presence of Bicycle Boulevards and Their Influence on Bicycle-to-Work Rates in Portland, Oregon. Ph.D. Thesis, Doctoral dissertation University of Oregon, Eugene, OR, USA, 2012.

32. Blanc, B.; Figliozzi, M. Modeling the Impacts of Facility Type, Trip Characteristics, and Trip Stressors on Cyclists' Comfort Levels Utilizing Crowdsourced Data. *Transp. Res. Rec.* **2016**, *2587*, 100–108. [CrossRef]

33. Dill, J. Bicycling for transportation and health: The role of infrastructure. *J. Public Health Policy* **2009**, *30*, S95–S110. [CrossRef] [PubMed]

34. Minikel, E. Cyclist safety on bicycle boulevards and parallel arterial routes in Berkeley, California. *Accid. Anal. Prev.* **2012**, *45*, 241–247. [CrossRef] [PubMed]

35. Surkan, D.G. The Effectiveness of Saskatoon's Bicycle Boulevard. *Univ. Sask. Undergrad. Res. J.* **2016**, *2*, 158. [CrossRef]

36. Delbressine, R. The Traffic Safety of Bicycle Streets in The Netherlands. Master's Thesis, Delft University of Technology, Delft, The Netherlands, 2013.

37. Speck, J. *Walkable City Rules. 101 Steps to Making Better Places*, 1st ed.; Island Press/Center for Resource Economics: Washington, DC, USA; Springer International Publishing AG: Cham, Switzerland, 2018; ISBN 1610918991.

38. VanZerr, M. Resident Perceptions of Bicycle Boulevards: A Portland, Oregon Case Study. In *Transportation Research Board 89th Annual Meeting*; Transportation Research Board: Washington, DC, USA, 2010.

39. Bamberg, S. Changing environmentally harmful behaviors: A stage model of self-regulated behavioral change. *J. Environ. Psychol.* **2013**, *34*, 151–159. [CrossRef]

40. Bamberg, S. Understanding and Promoting Bicycle Use—Insights from Psychological Research. In *Cycling and Sustainability*, 1st ed.; Parkin, J., Ed.; Emerald: Bingley, UK, 2012; pp. 219–246.

41. Olsson, L.E.; Huck, J.; Friman, M. Intention for Car Use Reduction: Applying a Stage-Based Model. *Int. J. Environ. Res. Public Health* **2018**, *15*, 216. [CrossRef]

42. van Acker, V.; van Cauwenberge, B.; Witlox, F. MaxSUMO: A New Expert Approach for Evaluating Mobility Management Projects. *PROMET Traffic Transp.* **2013**, *25*, 285–294. [CrossRef]

43. Hyllenius, P.; Rosqvistq, P.S.; Haustein, S.; Welsch, J.; Carreno, M.; Rye, T. *MaxSumo—Guidance on How to Plan, Monitor and Evaluate Mobility Projects. Integrated Project 6.2 Sustainable Development 1.6.2 Sustainable Surface Transport Objective 3.1.1.1.3 Advancing Knowledge on Innovative Measures in Urban Transport*; DTU Library: Lyngby, Denmark, 2009.

44. Keller, A.; Eisen, C.; Hanss, D. Lessons Learned from Applications of the Stage Model of Self-Regulated Behavioral Change: A Review. *Front. Psychol.* **2019**, *10*, 1091. [CrossRef]

45. Bamberg, S. Wie funktioniert Verhaltensveränderung? Das MAX-Selbstregulationsmodell. In *Mobilitätsmanagement: Wissenschaftliche Grundlagen und Wirkungen in der Praxis*, 1st ed.; Stiewe, M., Reutter, U., Eds.; Klartext: Essen, Germany, 2012; pp. 76–101, ISBN 978-3-8375-0474-3.

46. Nkurunziza, A.; Zuidgeest, M.; Brussel, M.; van Maarseveen, M. Examining the potential for modal change: Motivators and barriers for bicycle commuting in Dar-es-Salaam. *Transp. Policy* **2012**, *24*, 249–259. [CrossRef]

47. Kirschner, F.; Lanzendorf, M. The acceptance of urban parking policies. Empirical evidence from the neighborhood level. *J. Transp. Geogr.* **2019**. submitted for publication.

48. Sunio, V.; Schmöcker, J.-D.; Kim, J. Understanding the stages and pathways of travel behavior change induced by technology-based intervention among university students. *Transp. Res. Part F Traffic Psychol. Behav.* **2018**, *59*, 98–114. [CrossRef]

49. Winters, M.; Buehler, R.; Götschi, T. Policies to Promote Active Travel: Evidence from Reviews of the Literature. *Curr. Environ. Health Rep.* **2017**, *4*, 278–285. [CrossRef] [PubMed]

50. Yang, L.; Sahlqvist, S.; McMinn, A.; Griffin, S.J.; Ogilvie, D. Interventions to promote cycling: Systematic review. *BMJ* **2010**, *341*, c5293. [CrossRef] [PubMed]

51. Scheepers, C.E.; Wendel-Vos, G.C.W.; den Broeder, J.M.; van Kempen, E.E.M.M.; van Wesemael, P.J.V.; Schuit, A.J. Shifting from car to active transport: A systematic review of the effectiveness of interventions. *Transp. Res. Part A Policy Pract.* **2014**, *70*, 264–280. [CrossRef]

52. Finke, T. *Wirkungen von Mobilitätsmanagement-Programmen. Entwicklung Eines Evaluationsverfahrens*; Institut für Stadtbauwesen und Stadtverkehr RWTH Aachen: Aachen, Germany, 2009; ISBN 978-3-88354-155-6.

53. Louen, C. *Wirkungsabschätzung von Mobilitätsmanagement. Ansatzpunkte zur Modellierung & Ableitung von Potentialen und Wirkungen am Beispiel des Betrieblichen Mobilitätsmanagements*; Institut für Stadtbauwesen und Stadtverkehr RWTH Aachen: Aachen, Germany, 2013; ISBN 978-3-88354-166-2.

54. Busch-Geertsema, A.; Lanzendorf, M.; Müggenburg, H.; Wilde, M. Mobilitätsforschung aus nachfrageorientierter Perspektive: Theorien, Erkenntnisse und Dynamiken des Verkehrshandelns. In *Handbuch Verkehrspolitik*; Schwedes, O., Canzler, W., Knie, A., Eds.; Springer Fachmedien: Wiesbaden, Germany, 2016; pp. 755–779, ISBN 978-3-658-04692-7.

55. Prochaska, J.O.; DiClemente, C.C. Stages and processes of self-change of smoking: Toward an integrative model of change. *J. Consult. Clin. Psychol.* **1983**, *51*, 390–395. [CrossRef] [PubMed]

56. Prochaska, J.O.; Velicier, W.F.; Rossi, J.S.; Goldstein, M.G.; Marcus, B.H.; Rakowski, W.; Fiore, C.; Harlow, L.L.; Redding, C.A.; Rosenbloom, D.; et al. Stages of change and decisional balance for 12 problem behaviors. *Health Psychol.* **1994**, *13*, 39–46. [CrossRef]

57. Bamberg, S.; Fujii, S.; Friman, M.; Gärling, T. Behaviour theory and soft transport policy measures. *Transp. Policy* **2011**, *18*, 228–235. [CrossRef]

58. Schwartz, S.H. Normative Influences on Altruism. In *Advances in Experimental Social Psychology*; Berkowitz, L., Ed.; Academic Press: New York, NY, USA, 1977; pp. 221–279, ISBN 9780120152100.

59. Ajzen, I. The theory of planned behavior. *Organ. Behav. Hum. Decis. Process.* **1991**, *50*, 179–211. [CrossRef]

60. Bamberg, S.; Schmidt, P. Verkehrsmittelwahl—Eine Anwendung der Theorie geplantes Verhalten. *Z. Soz.* **1993**, *24*, 25–37.

61. Gatersleben, B.; Appleton, K.M. Contemplating cycling to work: Attitudes and perceptions in different stages of change. *Transp. Res. Part A Policy Pract.* **2007**, *41*, 302–312. [CrossRef]

62. Rose, G.; Marfurt, H. Travel behaviour change impacts of a major ride to work day event. *Transp. Res. Part A Policy Pract.* **2007**, *41*, 351–364. [CrossRef]

63. Stadt Offenbach am Main. *Statistischer Vierteljahresbericht der Stadt Offenbach am Main 1/2019. Erfassungszeitraum: 01. Januar bis 31. März 2019*; Stadt Offenbach am Main: Offenbach, Germany, 2019.

64. Stadt Offenbach am Main. *Statistischer Vierteljahresbericht der Stadt Offenbach am Main 3/2012. Erfassungszeitraum: 01. Juli bis 30. September 2012*; Stadt Offenbach am Main: Offenbach, Germany, 2012.

65. Stadt Offenbach am Main. *Fahrrad-(straßen)-stadt Offenbach. Vorhabenbeschreibung für den Bundeswettbewerb "Klimaschutz durch Radverlehr"*; Stadt Offenbach am Main: Offenbach, Germany, 2017.

66. Belz, J.; Brand, T.; Eggs, J.; Ermes, B.; Follmer, R.; Gruschwitz, D.; Kellerhoff, J.; Pirsig, T.; Roggendorf, M. *Mobilität in Deutschland-MiD Regionalbericht Stadt Offenbach*; infas: Bonn, Germany, 2019.

67. Nobis, C.; Kuhnimhof, T. *Mobilität in Deutschland-MiD Ergebnisbericht. Studie von infas, DLR, IVT und infas 360 im Auftrag des Bundesministers für Verkehr und Digitale Infrastruktur (FE-Nr. 70.904/15)*; Infas: Bonn, Germany, 2018.

68. Enders, C.K. *Applied Missing Data Analysis*; Guilford Publications: New York, NY, USA, 2010; ISBN 9781606236390.

69. OECD. What Are Equivalence Scales? OECD Project on Income Distribution and Poverty. Available online: http://www.oecd.org/els/soc/OECD-Note-EquivalenceScales.pdf (accessed on 28 October 2019).

70. El-Menouar, Y. Befragung von Migranten. In *Handbuch Methoden der Empirischen Sozialforschung*; Baur, N., Blasius, J., Eds.; Springer Fachmedien Wiesbaden: Wiesbaden, Germany, 2019; pp. 943–956, ISBN 978-3-658-21307-7.

71. Stadt Offenbach am Main. *Altersdurchschnitt der Offenbacher Einwohnerinnen und Einwohner am 31.12.2018 (Hauptwohnsitz)*; Stadt Offenbach am Main: Offenbach, Germany, 2019.

72. Backhaus, K.; Erichson, B.; Plinke, W.; Weiber, R. *Multivariate Analysemethoden. Eine Anwendungsorientierte Einführung*, 15th ed.; Springer: Berlin/Heidelberg, Germany, 2018; ISBN 978-3-662-56654-1.

73. Cureton, E.E.; D'Agostino, R.B. *Factor Analysis. An Applied Approach*; Psychology Press: New York, NY, USA, 2009; ISBN 1317759648.

74. Cleff, T. *Applied Statistics and Multivariate Data Analysis for Business and Economics. A Modern Approach Using SPSS, Stata, and Excel*, 1st ed.; Springer International Publishing: Cham, Switzerland, 2019; ISBN 978-3-030-17766-9.

75. Albers, S.; Klapper, D.; Konradt, U.; Walter, A.; Wolf, J. *Methodik der Empirischen Forschung*, 3rd ed.; Gabler Verlag: Wiesbaden, Germany, 2009; ISBN 3-322-96406-X.

76. Büttner, J. Bike Offenbach—Stärkung des Radverkehrs für den Klimaschutz durch neue Radverkehrsachsen. Master's Thesis, University of Applied Sciences, Darmstadt, Germany, 2019.

77. Schläger, N.; Wührl, B.; Woywod, T.; Fromberg, A.; Gwiasda, P.; Niklas, K.; Schreiber, M.; Pohle, M. *Sicherheitsbewertung von Fahrradstraßen und der Öffnung von Einbahnstraßen*; Forschungsbericht Unfallforscher der Versicherer No. 41; GDV: Berlin, Germany, 2016.

78. Klöckner, C.A.; Ofstad, S.P. Tailored information helps people progress towards reducing their beef consumption. *J. Environ. Psychol.* **2017**, *50*, 24–36. [CrossRef]

79. Handy, S.; van Wee, B.; Kroesen, M. Promoting Cycling for Transport: Research Needs and Challenges. *Transp. Rev.* **2014**, *34*, 4–24. [CrossRef]

80. Willis, D.P.; Manaugh, K.; El-Geneidy, A. Cycling Under Influence: Summarizing the Influence of Perceptions, Attitudes, Habits, and Social Environments on Cycling for Transportation. *Int. J. Sustain. Transp.* **2015**, *9*, 565–579. [CrossRef]

81. Graf, T. *Handbuch: Radverkehr in der Kommune. Nutzertypen, Infrastruktur, Stadtplanung, Marketing: Das Hygge-Modell, Ergänzungen zur ERA*, 1. Auflage ed; Les éditions Bruno: Röthenbach an der Pegnitz, Germany, 2016; ISBN 9783940217196.

82. Buehler, R.; Dill, J. Bikeway Networks: A Review of Effects on Cycling. *Transp. Rev.* **2015**, *36*, 9–27. [CrossRef]
83. Ricci, M. Bike sharing: A review of evidence on impacts and processes of implementation and operation. *Res. Transp. Bus. Manag.* **2015**, *15*, 28–38. [CrossRef]